

SATURDAY, APRIL 18, 1874.

[Entered according to Act of Congress, in the year 1874, by the RAIL-BOAD GAZETTE, in the office of the Librarian of Congress, at Wash-ington.]

Comparison of the Merits of the Mode of Building Iron Truss Bridges in America with the System Used in Europe.

BY CHARLES BENDER. C. E.

[Continued from page 130.]
[Translated with additions by the author from the Zeitschrift des Vereins deutscher Ingenieure.]
In comparing European with American bridges, differences

are met with in regard to class of material, its sections and strains, as well as with reference to the supposed movable

ands.

In both systems preferably wrought iron is used. The application of cast iron in Europe at present is confined to be plication or case from in Europe at present is commed to bed-plates and ornaments, while good practice in the United States permits its use for short chords of very heavy spans and for joint-boxes of wrought-iron bridges. The justification of this practice rests on the undeniable merits, for certain purposes, of this metal, as well as on the excellent qualities of the cast iron which can be secured in the United States, and on the from which can be secured in the United States, and on the high degree of perfection to which its working has been brought. Indeed, in principle there is no reason why short castiron joint-boxes of proper proportions should not be used, since we know that the lives of thousands of people daily depend on the safety of castings constituting the principal dethe most severe impacts. In Europe there exist numbers of good brands of cast iron of sufficiently good quality to be used in bridges, and the disasters which have happened there from cast-iron structures were rather due to bad design than to faults in the material.

Especially since the breaking down of a Howe bridge in Austria, built on the Schifkorn patent, Continental engineers seem to condemn cast iron completely, and to consider this material as a half-finished product, which in their opinion should not enter into the construction of a first-class railway bridge. However, it should be borne in mind that hardly a more improper use could be made of that material than the one intended by the Austrian engineer mentioned. Short joint-boxes, in structures of experienced American engineers.

are better designed and of sufficient thickness of metal.

Concerning wrought iron for tensile members, trustworthy European works use a metal of about the same tensile strength as that selected by responsible American firm.

The average of a great number of tests on iron intended

for use in a great Russian bridge, manufactured in Bel-

gium, is contained in	the su	psedren	ւ ոցա	es:			
Horizontal chord-plates,	tensile	strength	52,400	lbs.	extension	7 per	ect.
Vertical chord-plates .			51,700	44	44	6.15	66
Cover or joint plates			55,700		44	5.	66
Lateral wind-bars			49,600	66	44	5. 6	**
Angle iron			60.200	44	44	14.	66
Tensile diagonals					44	17.	
Shearing atrength of riv	ets (sin	gle row	48 900				

A few figures, determined by M. Morin for French iron are

	ngle iron from Hayange on the average			per square incl
- 1	lat	52,000	**	66
1	ingle iron from Ars sur Moselle	46,000	46	66
1	touble T iron	54 000	44	66
1	Mat iron	53,300	66	"

Again, for German iron the following figures were obtained by Mr. Woehler from iron furnished to the Maerkish-Silesian

	*				Strain on ultimate section.	Ext	ension.
	. in Ruhvort a				68,000		per ct.
46	44		49,500		73,400	22	44
Round iron	from Koenigs	huetse.			100,000	7	44
16	66		56,200		99,000	21	44
Rivet iron	from Borsig, it	Berlin	76,000	66	107,000	22	44
44	66	41	78,100	66	106,000	24	**

The English engineers prefer for their bridges an iron of more moderate ultimate strength and quality than that ap-plied by Continental or by American engineers. In Germany, under the constant and strict supervision of the railroad and Government officers, rolling mills have been compelled to work their material very thoroughly, and to add a complete working by the steam hammer before rolling a pile, this being for a short time returned to the furnace. The result of this mode of manufacture is a somewhat higher-priced material of a quality equal to the double-refined iron of mills which improve their article without the hammer by cutting, piling and

in

nei-

rise

The double-refined iron of first-class American firms stands, in small sections, ultimate strains as high as from 55,000 to 60,000 lbs., on the average 55,000 lbs.; but when rolled in larger sections, such as used in bridges, it will not surpas on the average the ultimate strength of the Continental materials. rial quoted, and the writer can produce tests of American double-refined iron of the best make which stood not more than 45,000 and even 40,000 lbs. when rolled into very thick However, it seems to be in the interest of railway com panies to prescribe an iron of medium strength, of about 50,000 lbs., but to insist upon the guarantee which is furnished by a maker who can command the uninterrupted use of a uni-form and high-grade forge-pig, and who enjoys a reputation too valuable to be put at stake.

An iron bar which under the hammer will bend 180 degrees ithout rupture, the space between the two ends being equal to the thickness of the iron, is good for any bridge; and if this test with the appearance of the ruptured surface is not considerable. ered a sufficient proof, the opinion of an honest and experienced blacksmith, in the writer's judgment, will weigh han the figures furnished by experimenting theorists.

What the bridge-builder wants is a material of original best stock, sufficiently and not over worked, which will extend a great deal before rupture. Bending without rupture over 180 degrees warrants this quality, and this was the only test prescribed for some contracts in the late Kingdom of Hanover. Cold and hot punching furnishes further indications as to quality, and the appearance of the surface faced by a cutting

As regards compression members, the hollow wrought-iron columns, introduced in the United States by Mr. Samuel Reeves, take the foremost rank. This gentleman has proved by sufficient tests that the crushing strength of the material in his compression members is about twice as high as that which Hodgkinson thought to have established for wrought iron. Mr. Reeves' results agree with other experiments made in the United States, as well as with those of Mr. Woehler in Germany, who did not succeed in crushing pieces of wrought iron or steel even when only three diameters long, and who found that these pieces invariably broke by flexure. Woehler has also furnished undoubtedly correct proofs that the tensile strength of iron is lost by continued use previous to the com-

This observation is furthermore established by the observation that carriage axles when breaking always start from the tensile part (showing rust in case of rupture), whilst the comressive part has not suffered at all.

The English experiments made on eye-bars also proved nothing less than that the crushing strength of the iron was at least 33 per cent. greater than its tensile, or else a 3-inch pin could not have stood the pressure equivalent to a 4-inch bar.

French and German engineers have never accepted the con-clusions drawn by Mr. Hodgkinson and his friends. General cusions drawn by Mr. Hodgkinson and his friends. General Morin, in his valuable treatise on experiments, refutes the English theory completely, and the formula which Mr. Reeves has constructed on his columns, with the exception of the very greatest lengths, agrees even with the theoretical expression indicating the section for which the maximum strain will never reach the amount of one-half of the elastic limit, and which consequently could only be expected to be true within this limit.

All that is necessary is to form a compressive member which will not in the least bend out laterally when a pressure is brought on it twice as large as that which, by the very greatest possible live load under the highest speed, is imposed on a member of a bridge. Since we know that under such circum-stances the tensile parts and the connections will wear out first, there is no reason why the highest pressure should be reduced to 80 per cent. of the maximum tension. Continental engineers very properly strain the iron equally high under tension and compression, of course modifying the pressure according to lengths and diameters.

American engineers in general are shead of the Europeans in the use of shape iron for bridges. While these, as it were, strain the principle of the exclusive use of plates and angles to its farthest limits, American builders prefer special shapes. They thereby not only have reduced the abuse of rivets; they also have obtained stronger forms.

Any engineer familiar with the mechanical processes in rolling mills and riveting shops, without any experiment what-ever, will know that a riveted girder cannot possibly equal in ever, will know that a riveted girder cannot possibly equal in strength or durability a well-designed and well-manufactured rolled girder of corresponding proportions and weights, even if the first, with the expense of a very great number of well-placed rivets, should prove to be of equal ultimate strength under a single experiment. The riveted girder must necessarily deflect more than the rolled girder, and it must wear out sooner under repeated strains inside of the elastic limit.

Shortly after the time when double T beams were invented by Mr. (Figher in France (1848) in that country great ever.

Shortly after the time when double I beams were invented by Mr. Chibon in France (1848), in that country great exer-tions were made to benefit engineering by its rapid progress in the art of rolling. But the engineers to whom in this re-gard the greatest credit is due, as Zores, Schweikardi and others, were unable to disarm the powerful reaction which since the erection of the Britannia Bridge spread over Europand which at present still remains in force. Suggestions such Suggestions such as were made in the same direction by Mr. Heusinger von Waldegg, as early as the year 1963, have not been accompanied with as much success as they deserved.

The American bridge engineers, therefore, still are ahead of the Europeans in the utilization of this principle of forging the iron while it is hot, and it is to be hoped that the prices of shapes may not be so high as to force them to return to the less mechanical English practice.

The live loads for which American bridges are constructed at present are much greater than those quoted in European books. They have been steadily increased with the rolling stock, traffic and speed. Of course for new and long roads, which, like those of the Far West, form but the pioneers of civilization, it would neither be necessary nor practicable to apply the rules suited for a country which has been fully developed and inhabited for 2,000 years, and where the road pays from the day of its completion, even when its cost has been four times as large as a first-class American line.

Leading American engineers build their bridges, if not speci-fied otherwise, for a train imposing a gross ton per foot of length, headed by the heaviest freight engine, which concen-

length, headed by the heaviest freight engine, which concentrates about 80,000 lbs. on 15 feet of wheel-base.

The Eric Railway engineers prescribe, for double-track bridges, the calculation for movable loads decreasing from 4,000 lbs. for small spans to 2,500 lbs. per foot of track of the largest spans, and they prescribe a movable load of 5,000 lbs. per foot and track with a factor of safety of six for the floor system.

The New York Central Railroad prescribes from 4,000 to 3,000 lbs, per foot of track; the Lehigh Valley road orders double-track bridges designed for movable loads of 3,000 lbs, per foot of track and for 4,500 lbs, on the panel and floor

The introduction of separate calculations of floors with reference to concentrated engine loads started from Europe and is repeatedly pointed at in Laissle and Schuebler's work on bridges, of the year 1857. Lately European writers recommend the calculation of the whole web system for loads larger than that for the chords.

It used to be the general rule in France to suppose live loads of 2,670 lbs. per lineal foot, maximum tension equal to a maximum compression of 8,500 lbs. per square inch.

The latest Austrian law (August, 1870) prescribes for differ-

ent lengths of girders or trusses the following live loads:

Spa	n, 3	feet	20,000 lbs	. per	foot.
66	6	66		65	46
3.6	16		6.606	96	64
.64	66	46		44	66
46	100	80	and more 2,666	44	64

The floor is to be constructed on the same principle, with the additional consideration of the passage of locomotives, each axie of which imposes 30,000 lbs.

In Germany generally three heavy engines followed by the heaviest freight cars are supposed.

The edition of 1857 of the work of Laissle and Schuebler

The edition of 1857 of the work of Laissle and Schuebler supposes a train of three locomotives and three tenders followed by freight cars. Each locomotive carries three axles each loaded with 12 tons weight; each tender carries three imes 6 tons. Length of engine 24 ft. 7 in.; length of tender 19 ft. 8 in. The freight cars weigh 2,000 lbs. per foot. Each locomotive with tender weighs 2,667 lbs. per foot and concentrates 80,000 lbs. on 13 feet of wheel base.

The live loads under this supposition are for spaces of

The live loads, under this supposition, are for spans of

23 tt. 33 ft. 50 ft. 90 ft. 100 tt. 200 ft. 328 t. and mor Lbs. per foot. 4,133 3,623 3,100 2,960 2,630 2,633 2,467 for chord " ...5,867 4,800 4,100 3,733 3,466 3,100 2,600 for webs.

Of special interest is the specification under which the Kre-mer & Klett Company, in Germany, used to construct their nmerons bridges.

They, very properly, refer the strains of the material not to the ultimate strength but to that limit from which extensions

and compressions begin to become visibly permanent.

The iron which they use shows this limit with 23,000 lbs, per square inch, and the sections of their bridges are determined so that the single strain from static load plus the three-foid strain from live load will be equal to the elastic limit. Under

strain from live load will be equal to the elastic limit. Under the specification, very properly, short bridges are built comparatively stronger, and the influence of the impacts caused by passing trains is taken into calculation.

In the descriptive pamphlet on the Mainz Bridge, published by Mr. Gerber in the year 1863, the movable load is still supposed as a rather light one, namely, to consist of a train of three locomotives of 45 tons, each 44.3 feet long, followed by freight cars of 16 tons, each 18 feet long. Under this specification the strains and live loads are, for spans of 33 ft. 66 ft. 100 ft. 200 ft. 300 ft. 325 ft. Strains....8,700 9,100 9,500 10 500 11,360 11,600 lbs. per sq. inch. Live load..3,200 2,700 2,460 2,100 2,000 1,900 lbs. per foot.

These strains refer only to the main trusses of the bridge.

These strains refer only to the main trusses of the bridge, and the floor again is calculated with consideration of the greatest accumulation of load arising from the engines, the basis of 8,500 lbs. per square inch (600 kilo. per sq. centimeter) being sustained for the strains.

American engineers, as a rule, still adhere to the practice of specifying the maxima strains with reference to the ulti-mate strength, and of straining the iron tensionally to 10,000 lbs. per square inch.

lbs. per square inch.

But the most scientific and at the same time the leading builders have taken steps toward introducing the principle that those parts which come in contact with the direct effect of the movable load must be strained less, and very lately specifications almost identical with Mr. Gerber's have been recommended repeatedly.

We now proceed to a comparison of the two systems with

Previous to the time when the great English tubular and lattice bridges were built, connections were applied in Europe which, in point of principle, did not differ from those at pres-ent preferred in the United States.

ent preferred in the United States.

The Bayarian engineer Reichenbach, in the year 1792, was the first who recommended and later introduced hollow castthe first who recommended and later introduced hollow castiron columns for arch bridges. Then Hoffmann, in Hungary, in the year 1837 built the first bowstring girder with cast-iron curved top-chord, composed of hollow columns, and with wrought-iron diagonals and hangers. Wiegmann, in Prussia, in an elaborate article, in the year 1838, had described his trusses for bridges and roofs, which only by the independence of the sub-systems differ from those introduced by Albert Fink in America, and which first were introduced into practice by nceau in France.

The Hanoverian engineer Laves had communicat The Hanoverian engineer Laves had communicate the features of his fish-belly trusses to the English engineer Brunel as early as 1834. He also had sent a model to this gentleman, and covered his invention by an English patent. He wrote a pamphlet on his system in the French language in the year 1835, and after 1839 carried out his plans frequently in wood and in iron with bolt connections. He likewise built a wroughtiron draw on the same plan. Already, in the year 1840, the Belgian engineer Neville had invented the triangular truss; beginn engineer Neville had invented the triangular truss; he ha' introduced the same into practice during the year 1845, and built many bighway and railway bridges on his plaus in Belgium, Germany and Austria. His arrangements, with improved details and with pin connections, were introduced in England under the name of "Warren girders."

These girders, in their executions as the Company trusted in the connections as the Company trusted in the connections.

These girders, in their executions as the Crumlin viaduct and the Newark Bridge, became of great importance to the Americans, who selected proper details for introduction of trusses composed of cast and wrought iron, which had to be constructed with all possible economy in order to compete

with cheap wooden bridges.

The comparatively high price of riveted girders prevented the American engineers, very fortunately and at the same time accidentally, from adopting the arrangements and the principles which their English cousins had recommended in

A

their publications with so much ability, leading, by means of the investigations and experiments of Barlow, Hodgkinson, Stephen on, Fairbairn, and others, the old world into a channel which, since the success of the Britannia Bridge, was followed but too willingly and too exclusively.

Great, and doubtless most important as the results of the investigations of those English engineers at that time were, nevertheless they should not have been accepted as exclusive dogmas, since no pains had been taken to examine with equal care the opposite way, by which the problem could be solved hanically.

It is the merit of the American engineers to have done this and to have proved practically that pin connections indeed, if properly arranged, offer greater advantages for bridges and similar structures than can be expected from rivet joints,

more especially for large spans.

For some time doubts have been expressed whether the rules given by the English engineers mentioned are correct with reference to rivet-connections. The question has been discussed and has been investigated whether punching of rivet holes is not less mechanical than drilling. Experiments have been made, and in connection with proper arguments results have been obtained which throw new light on this mode of making connections, and finally, conclusions have been reached, which no longer admit of considering these joints as perfect.

Mere arguing already leads to the conclusion that any hole punched or drilled in a bar, not only diminishes its cross section, but that it must necessarily change the previously uniform distribution of strains over the remaining part of the section of the bar in such a manner that much larger strains must be produced in the neighborhood of the hole. Apparently this phenomenon originates from the strains which exist in the strip lost by the hole and which by shearing force must be transferred to the remaining section of the bar. The maximum strain being the deciding one, necessarily the efficiency of its not area must be diminished in the same ratio as the maximum strain is larger than if the total strain were uniformly distributed over this section.

Anyone can convince himself easily of this truth by executing the section of the section of the section of the section.

Anyone can convince himself easily of this truth by executing Mr. Forney's experiment of punching a round hole in a sufficiently long rubber band, of preparing with a lead pencil two parallel lines close to and equally apart from the center of the hole across the band, and of finally rolling each of the ends of the band over a lead pencil. By drawing these two pencils apart uniform strains will be produced over the area of the band, but in the neighborhood of the hole the pencil lines will no longer be parallel, but will be remarkably further apart than pear the outside edges of the rubber band, thus proving that near the outside edges of the rubber band, thus proving that the tensile strains near the hole must be larger than the near to the edges.

The American Master Mecha ics' Ass experiments on perforated plates, and has found that with punched holes there is connected aloss of 36 per cent., and punched holes there is connected a loss of 36 per cent., and with drilled holes there is still a loss of 16 per cent. of the original strength of the remaining net area. Having found this result, the experiments were continued with single shearing rivets, under which the connections were almost equally strong whether the holes had been punched or drilled. The strength of the joints was about 20 per cent. weaker than could be expected from the original strength of the net area of the iron, which is a result about agreeing with Mr. Fairbairn's experiments. The American experiments consequently gave evidence that a part of the loss of strength by punching was replaced by the friction of the rivet heads, so that the punched and riveted plates finally equalled those with drilled holes and on account of the less sharp edges of the holes rather showed a slight advantage. The investigation of the strength of rivet joints of punched or drilled plates, by reasons of arguments as well as of the reported experiments, leads to this conclusion: A rivet joint without the proper fraction must be connected with a loss of the original strength of the remaining area of the joined plates. The friction does not simply increase the strength of the joint, which by English and also by French engineers for a time was considered to be sufficient if only the holes were filled properly. But on to be sufficient if only the holes were filled properly. But on the contrary any rivet joints without the sufficient friction caused by the heads must be considered to be weater than the original strength of the reduced area of the joints. It is only with joints of three rows of rivets one behind the other (single as well as double shearing) that it is possible to reach the original strength due to the iron of the net area of the most

This very essential head-friction equalizes the strains, but it is not at all represented in any of the formulæ given for such joints. From this we also are led to conclude that these formulæ are not as trustworthy as we are informed, since so much depends on the degree of friction, which again rests on the degree of heat of the rivet, on the ductility of the rivet iron, as well as on the more or less unreliable degree of perfection of execution.

Any of these rivet calculations, besides, is very rough, and is based on utterly unscientific suppositions, for the strains in the rivet-holes and rivets themselves are of an exceedingly complicated nature and cannot be determined with even the application of the highest analytical mechanics.

Another point of great importance, and one which has not yet received sufficient attention, is this, that experiments on

poses of bridge-building, it will be indispensible to test the poses of bridge-building, it will be indispensible to test the different modes of making joints on repeated strains and impacts in a manner similar to that used by Mr. Woehler for plain bars. It also will be indispensible to cut pieces from ordinary girders which were manufactured without the intention of being used for experiments, and at the same time it would be necessary to test in the same manner carefully qualities and the strength of the same material of which the riveted joints were made. With such tests practical rules could finally be obtained.

It is rather difficult to improve the present formulæ by intro ducing the friction, for it can hardly be calculated. Only this much we do know, that the heads of new and well-driven rivets exert friction which corresponds with the extension of the shank beyond the elastic limit.

At present we only have to deal with experiments made on joints with plates of small sections. The diameters of the rivets also were small and their heads easily formed. These joints could very easily be executed with sufficient care, and certainly were made by using the best material.

Thus Fsirbairn's original experiments, published in his book on "useful information," were made with iron of only % square inch of section, not quite ¼ inch thick, the rivets having diameters of but ½ inch and ½ inch. The experiments of the Master Mechanics' Association were made on plates of but 0.35 square inches of net section and with ½ inch rivets. ch rivets can be driven easily and, as is usually the with such experiments, most probably they were considerably stances of manufacture. Especially may it be expected that the holes fitted exactly and were carefully prepared with reamers and not with drift-pins. The rivet shanks were only % inch long.

Notwithstanding these advantages in fivor of the rivetjoints, Mr. Fairbairn's report gives evidence that his machine-made joints were about 20 per cent. stronger than those made by hand, and that hand-made join's executed with special care proved to be 14 per cent. stronger than if made with ordinary care. This result is plausible, and the joint-plates being only two in number and only 0.22 inch thick, what differences of strength may be expected wien, as in the Dniester Bridge, near Tiraspol, in Russia, 16 %-inch plates have to be oined by 1-inch rivets.

According to the wrriter's knowledge only few experiments can be recorded of rivet joints with stronger plates (as for instance Brunel's experiments with 1/2-inch plates). These, how-ever, prove that joints with two rows of rivets give a strength of about 94 per cent. of the original value of the ret area. while three-row riveting resulted in the utilization of the full strength. Since we know that single-row joints give a utilization of 80 per cent., according to Brunel's experiments, we are led to assume that the second row adds 14 and the third row the final 6 per cent. of strength. Here it must be remarked what great amount of labor is needed in order to achieve this end. It also should not be overlooked that even in these experiments the rivet shanks were only one inch long, that we have to deal again with tests made on specimens prepared for the purposes of experimenting. Also the iron was of the Staffordshire c ass, and probably remarkably ductile. Experiments with such iron will be very favorable to the re

sults, much more so than would be the case if the ductility of the iron had first been removed by cold rolling. Under this condition but small changes of form would have preceded the rupture, and the favorable equalization of strains and of the pressures in the holes would have been replaced by conditions more like those which happen to a bridge whose iron by the maximum movable loads is only subjected to strains within the so-called limit of elasticity.

The construction in the shops of large structures with riveted oints is still connected with other difficulties. These consist in forming the joints of angle irons, for which, according to the writer's knowledge, we have no experiments; further they consist in the contraction of the rivet iron when cooling, also in the necessity of close packing of many plates, and in the more or less imperfect upsetting of the rivet shauks, the effect of which again is diminished by contraction.

It is true that the coincidence of the holes and the close packing of the plates can be and is secured in all European first-class establishments by the use or almost perfect punchfirst-class establishments by the use or almost perfect punching machinery, and, better still, by boring through all plates at once, as well as by previously rolling the plates, which, for this purpose, have been brought to a dark red heat and have been cleaned from scale. But the two other conditions cannot be fulfilled with perfect safety, and have therefore been avoided by the use of turned, tapering bolts, as in the Rhine bridge at Mainz, or by cold riveting of turned bolts in Rhymen's Hungarian bridges. But in these structures bolts in Ruppert's Hungarian bridges. But in these structures the metal must necessarily be less utilized, since the friction of the rivet heads does not assist, and therefore a loss of about 16 per cent. must be expected.

The longitudinal tension connected with the contraction of well-driven rivets, as any practical iron man will know, is con nected with the effect that the rivet heads will fly off if the rivet iron is not of great ductility and of a quality to be very strong under ordinary temperature. It is known how easy it is to cut off the heads of rivets by giving a few blows on a chisel set transverely against it, and it is also known that the yet received sufficient attention, is this, that experiments on riveting carried to the ultimate strength are unfair in principle when applied to the wants of bridge building. Bridges and similar structures of proper design and under the supposition of proper material and execution will not break down by imposing ultimate loads; but, as Mr. Woehler has discovered and has proved so as to leave no doubt, may break down after a sufficiently large number of repeated strains lower than the ultimate strength of the material.

If we must have trustworthy rules at all for the strength of rivets or of pin joints, beisg such as to coincide with the purfracture always looks crystalline, since the iron was under a state similar to the artificial condition of hardened steel. Dur-

reported that the Victoria Bridge in Canada loses its rivet heads in such number that pails filled with them can be no-ticed, and that new rivets have to be placed continually. Even hollow columns, as long as the rivets were not made of a spe cial brand of iton, lost their heads when exposed in the yard to the direct effect of the sun.

The longitudinal tension caused by contraction of a rivet must be considered as a constant value, and, as long as the same is not remarkably increased by strains arising from the movable load, its wear and tear will not progress as rapidly as when the heads are repeatedly exerted and finally loosened by vibrations and direct strains. This is the reason why rivets such as those which connect laterally the staves of a compr sion member must be considered as sufficient, while th rivets which serve to transfer tensions and compressions by means of cover-joints are by far less reliable and must necessary sarily sooner wear out than the rest of the girder.

All these arguments lead to the conclusion that riveting does not prove to be as perfect and as faultless as many engineers m to believe.

From the experiments with single rivet-joints we turn to experiments made on finished girders. These divide into experiments on flexure, into experiments on ultimate strength under a single test and in such by which the final rupture was caused by repeated strains less than the ultimate strength and

TO BE CONCLUDED NEXT WEEK. 1

Transportation in Congress.

In the Senate on the 9th: The bill for the incorport

ortation and regulation of railroad

The bill for the incorportation and regulation of railroad companies in the territories was taken up. On a motion of Mr. Wright, of Iowa, the section giving right of way 200 feet wide through all public lands, with authority to take from such lands all materials needed for the construction of road and buildings was struck out.

On motion of Mr. Bayard, of Delaware, the section authorizing corporations to acquire by purchase or gift any land in the vicinity of the road and convey them at the pleasure of the directors was struck out.

the vicinity of the road and convey them at the pleasure of the directors was struck out.

On motion of Mr. Pratt, of Indians, an amendment was made so as to grant for stations and other structures 10 acres of public lands per 10 miles of road, instead of 40.

On motion of Mr. Clayton, of Arkansas, an amendment was made requiring every company to maintain an office somewhere on its line and keep its books there open for inspection.

On motion of Mr. Hager, of California, the bill was amended so that it shall not some to the principle of the contract of

ction.

tion of Mr. Hager, of California, the bill was
so that it shall not apply to the District of

On motion of Mr. Hager, of California, the bill was amended so that it shall not apply to the District of Columbia.

The discussion was resumed on the 10th, and the motion of Mr. Buckingham, of Connecticut, forbidding the crossing of any Indian reservation by any road was agreed to. The amendments thus made in Committee of the Whole were concurred in by the Senate.

Mr. Wadleigh, of New Hampshire, offered the following amendment, which was agreed to:

That Congress may, at any time when in its opinion the public good may require it, add to, after, amend, or repeal this act, and whenever any Territory or any part thereof in which the railroad is located shall be admitted into the Union as a state, the Legislature of any such State may at any time add to, after, amend, or repeal this act, so far as it relates to any such railroad, or any part thereof which shall be within the territory of said State.

Mr. Bayard, of Delaware, moved an amendment to provide that, in organizing a corporation for the construction of a road, a majority of the persons applying for the charter shall be resident in the Territory or Territories where the railroad proposed is to be built. Agreed to.

Mr. Bayard offered an amendment providing that the amount of capital stock of any road shall not be less than \$10,000 per mile. Agreed to.

In the Senate on the 13th, in Committee of the Whole, the discussion of the general railroad law for the Territories as resumed. Mr. Wadleigh's amendment, adopted Friday, was amended so as to provide that Congress only may add to, alter, amend or repeal the act. Amendments were agreed to giving to the Legislature of any State which may hereafter be formed out of a Territory in which a railroad authorized under the act may be located, the same power over such corporation as it would have over one of its own creation; making the stockholders of any road organized under the act individually liable for an amount equal to the amount of stock subscribed for by them for all debts contracted by the road; and decla

Mr. Conkling offered a substitute for the liability clause of Mr. Pratt, that every stockholder in every corporation to be formed under this act shall be liable for all debts of said corporation contracted while he held the stock to an amount equal to the amount of stock of which he is the holder, at the par value thereof. Agreed to.

The bill was then read a third time and passed—Yeas, 30; nays, 18.

The bill was their read and any analy, 18.

In the Senate, on the 14th:
Mr. Scott, of Pennsylvania, from the Committee on Finance, reported back the bill to provide for the payment of the bonds of the Louisville & Portland Canal Company, with a recommendation that the House's substitute for the bill be adopted with certain amendments. Placed on the calendar.
Mr. Dorsoy, of Arkansas, introduced a bill to incorporate the Washington City & Atlantic Ocean Railroad Company. Referred to the District Committee. Also, a bill to establish a National Railroad Bureau. and for the general government of railroads. Referred to the Transportation Committee.

Train Accidents in March.

On the afternoon of the 1st, a car of a stock train on the New York Central & Hudson River Railroad was thrown from the track by a broken flange as the train was crossing the bridge over Genesee River at Rochester, New York. The car went off the bridge and down into the river, falling on its

side, and was badly wrecked.

On the evening of the lat, on the Central Pacific road near Blue Canon, five engines attached to a snow plow ran off the track, doing much damage and blocking the road eight hours.

hours.
On the morning of the 2d, on the Burlington & Missouri River Railroad near Burlington, Ia., a-plug blew out of a flue and the engineman and fireman were badly scalded, the latter being further injured by jumping from the engine.
On the 2d, on the Cnicago, Dubuque & Minnesots road near Gordon's Ferry, Ia., a plug blew out of the boiler and the engineman and fireman were badly scalded by the escaping

steam. The fireman jumped from the engine and was killed.
On the night of the 2d, near Truckee, Nev., on the Central
Pacific Railroad a freight train went off the track and into the
ditch. There was much snow on the track at the time.
On the 2d, a construction train on the Baltimore, Pittsburgh
& Chicago Railroad jumped the track near Chicago Junction,
O. The whole train went into the ditch and the conductor was
killed.

killed. On the morning of the 3d, a special train on the Chicago, Burlington & Quiney road loaded with delegates to the Kane County Farmers' Convention was thrown from the track by a misplaced switch near Geneva, Ill., and the engine was dam-

Burlington & Quincy road loaded with delegates to the Kane County Farmers' Convention was thrown from the track by a misplaced switch near Geneva, Ill., and the engine was damaged.

On the morning of the 3d, on the Buffalo & Jamestown road near Eden, N. Y., several cars of a mixed train were thrown from the track by the breaking of a truck under a freight car.

On the afternoon of the 3d, on the Keokuk & Des Moines Railroad near Comstock's, Ia., seven cars of a freight train were thrown from the track and wrecked by a broken rail. A brakeman was injured.

On the night of the 3d, in Norfolk, Va., on the Atlantic, Mississippi & Ohio road, as a freight train was backing up to the denot two cars jumped the track.

On the night of the 3d, on the Detroit, Lansing & Lake Michigan Railroad, near Hewell, Mich., a passenger train was thrown from the track and wrecked by a tree which had fallen across the tra k.

On the night of the 3d, on the Marietta Pittaburgh & Cleveland Railroad, near Phillipsburg, O.. the engine of a passenger train was thrown from the trock and slightly damaged by a white oak sapling which had been put on the track and fastened by running one end down into a water-way. A few minutes before the same train had passed without injury a rail laid across the track.

On the morning of the 4th, on the New York, New Haven & Hartford road near Thompsonville, Conn., as some ties were being thrown from a flat car while the train was in motion, one fell on the track and threw three cars into the ditch.

On the Morning of the 4th a steamchest exploded on an engine in the yard at Richmond, Ind., on the Pittsburgh, Cincinnat & St. Louis Railway.

On the 4th, a stock train on the Toledo, Wabash & Western Railway ran over a cow about two miles east of the Hannibal Brudge. The engine and nine cars went into the ditch and a number of cattle were killed.

Late on the night of the 4th, on the Toledo, Wabash & Western Railway ran over a cow about two miles east of the Hannibal Brudge. The engine and nine cars went into t

eral cars were thrown down the bank, and two brakemen injured.

Early on the morning of the 5th a train on the Macon & Brunswick road ran off the track near Jesup, Ga., wrecking several cars and injuring 16 persons.

On the morning of the 5th, on the Central Railroad of New Jersey, near Roselle, N. J., a coal car jumped the track and running across threw from the track several cars of a freight train which was passing on the other track.

About noon on the 5th, a train on the Norristown Branch of the Philadelphia & Reading road was thrown from the track by a misplaced switch at Conshohocken, Pa. The engine was badly wrecked and the road blocked some hours.

On the night of the 5th, the baggage car and two coaches of the west-bound express train on the Indianapolis, Bloomington & Western road were thrown from the track near Leroy, Ill., by the spreading of the rails.

On the morning of the 6th, on the Vermont & Massachusetts Railroad, the brakebeam of the tender of a freight train fell on the track as the train was crossing a bridge near Baldwinsville, Mass., throwing five cars from the track and badly damaging the bridge.

On the 6th, two engines and a snow-plow on the Central

Mass., throwing ave case.

On the bridge.

On the 6th, two engines and a snow-plow on the Central
Pacific road ran off the track near Wells, Nev., killing a brake-

on the 6th, two engines and a snow-plow on the Central Pácific road ran off the track near Wells, Nev., killing a brakeman.

On the night of the 6th, at Kasakakee, Ill., a north-bound mail train on the Illinois Central ran into some freight cars which had been blown by a heavy gale from a siding to the main track, wrecking two cars and dam ging the engine.

On the night of the 6th, on the Illinois Central at Paxton, Ill., a south-bound express ran into two cars which had been blown from a siding on to the main track. The engine was badly damaged.

On the 7th, on the Central Pacific road near Verdi, Nev., a snow-plow jumped the track and went down a bank 25 feet high, nijuring the conductor and a brakeman.

On the afternoon of the 7th, on the Central Pacific Railroad near Blue Canon, a snow-plow and one of the engines driving it went off the track in a heavy snow storm.

On the afternoon of the 7th, a train on the Muscatine Division of the Burlington, Cedar Rapids & Minnesota was crossing the bridge over Wapsic Creek, it gave way and the train went down into the creek. One abument of the bridge had been washed out by a freshet.

On the afternoon of the 7th, on the Detroit, Lansing & Lake Michigan road, near Salem, Mich., the bouler of a locomotive attached to a freight train exploded, wrecking the engine and injuring the engineman and the roadmaster, who was riding with him. The brirel of the boiler was torn to pieces, but the frebox and rear end were not much damaged. The engineman had just shut off steam. No cause is assigned for the explosion of the boiler, which was about two years old.

On the evening of the 7th, on the Philadeiphia, Wilmington & Baltimore, near Old Road station. a car of a passenger train jumped the track, blocking the road for an hour.

On the evening of the 8th, on the Texas & Pacific Railroad, near Scott's Station, a passenger train ran over a bull, throwing the engine into a ditch and injuring the engineman so that he died in a few hours.

On the evening of the 8th, on the Texas & Paci

d-ed

30 ;

m-ted

the

badly.

On the evening of the 9th, on the Texas & Pacific Railroad, a construction train, the engine of which was running backward, ran over a cow near Dallas, Tex., throwing the tender from the track and killing a laborer, who was on the tender. On the night of the 9th some cars of a freight train on the New York Central & Hudson River road were thrown from the track between Utica and Frankfort, blocking the road some hours.

hours.

On the morning of the 10th, on the Eric Railway, near Deposit, N. Y., a freight train ran off the track, cbstructing both tracks for several hours.

On the 10th, on the Syracuse Northern road, the engine drawing the pay-car ran off the track near Holmesville, N. Y., delaying trains some hours.

On the morning of the 11th, a north-bound freight train on the Petersburg Railroad was thrown from the track between Stony Creek and Ream's, Vs. On the 11th, a south-bound freight train on the Petersburg Railroad went into the ditch near Pleasant Hill, Va., wrecking

Bailroad went into the ditch near Pleasant Hill, Va., wrecking several cars.

On the 11th, on the Chicago & Lake Huron, near Millett's, Mi.h., several cars of a mixed train were thrown from the track and in o the ditch by a broken wheel.

On the night of the 11th, six cars of a treight train on the Amboy Division of the Pennsylvania Railroad were thrown from the track and wrecked near White Hill, N. J.

On. the 12th, the engine of a freight train on the New York Division of the Pennsylvania Railroad ran into a New Jersey Central train at the crossing of the two roads in Elizabeth, N. J., badly damaging the Central tender.

On the 12th, the engine of a mail train on the New York & Oswego Midland road was thrown from the track near Westfield, N. Y., blocking the road two hours.

On the afternoon of the 12th, at Oshkosh, Wis., on the Chicago & Northwestern Railroad, the locomotive of a freight train jumped from the track and came down on a side track six feet distant with all the wheels on the rails. The tender was thrown across the track, the cars all remaining on the rails.

was thrown across the track, the cars all remaining on the rails.

On the night of the 19th, on the Missouri Pacific, 10 miles west of St. Louis, a freight train ran off the track and blocked the road some time.

On the night of the 12th, a freight train on the West Wissonsin Railroad was thrown from the track by a misplaced switch, blocking the road some nours.

On the night of the 12th, on the Membhis line of the Louisville & Nashville road, near Stanton, Tenn., aneast-bound passenger train ran over a cow and went into the ditch, severely injuring the engineman, fireman and a lady passenger who jumped from the train.

On the morning of the 13th, in Mansfield, O., at the crossing of the Atlantic & Great Western and the Lake Eric Division of the Baltimore & Ohio, a switching engine of the latter road struck the engine of an Atlantic & Great Western freight train with just force enough to throw it from the track. The engine ran along on the tics some 30 feet and upon a Howe trass bridge when it turned over, wrecked the bridge, and went down into the creek, killing the engineman.

On the morning of the 13th, on the Kansas City, St. Joseph & Council Bluffs road, three miles from Council Bluffs, Ia., a sleeping coach jumped the track, delaying the train some hours.

On the morning of the 19th, an ore train on the Virginia &

A Council Bluffs road, three miles from Council Bluffs, Ia., a sleeping coach jumped the track, delaying the train seme hours.

On the morning of the 13th, an ore train on the Virginia & Truckee Railroad ran into a land slide at American Flat, Nev., wrecking the engine and several cars.

On the 13th there was a butting collision between a stone train and a freight train on the Indianapolis, Cincinnati & Lafayette road, near Acton, Ind.

On the 13th, on the Syracuse Northern Railroad near Hastings, N, Y., 16 ore cars were thrown from the track, blocking the road half a day.

On the evening of the 13th, on the Morris & Essex Division of the Delaware, Lackawanna & Western Railroad, the engine of a passenger train jumped the track at Washington, N. J., blocking the road some hours.

Early on the morning of the 14th, on the Iowa Division of the Chicago & Northwestern near Blairstown, Ia., the engine and six cars of a freight train were thrown from the track by a broken rail, killing a brakeman and injuring the engineman and fireman.

On the morning of the 14th, near Toano, Nev., two cars of a passenger train were thrown from the track by a broken rail and went down the bank, injuring one passenger.

On the 14th, on the Central Pacific near Blue Canon, a snow-plow and five engines ran off the track, blocking the road nearly a whole day.

On the 14th as a locomotive of the Penn-ylvania Railroad stood near the cinder pile in the yard at Altoona, Pa., waiting to be cleaned out, a laborer jumped on and started her backward. She ran into another engine and the man becoming frightened reversed the lever and jumped off, leaving the throttle wide open. The engine ran through the round house, through a long much damage to the machinery in the shop, killing one man and badly injuring another.

On the might of the 14th, on the Eric Railway in Paterson, N. J., the connecting rods of an engine broke, damaging the engine badly and throwing if from the track.

Early on the morning of the 16th, on the Mebile & Montgomery road near G

Cincinnati, Hamilton & Indianapolis road was thrown from the track at Morristown, Ind. The engineman jumped and was badly hurt.

On the morning of the 16th, on the Mobile & Montgomery road near Greenville, Ala., a culvert gave way under a passenger train. The engine passed over safely, but the tender and two cars went down and were badly wrecked. The culvert had been weakened by a heavy freshet.

On the morning of the 16th, a passenger train on the North & South Railroad of Georgia went through a trestle bridge which had been undermined by a flood, killing the engineman and badly injuring the fireman.

On the morning of the 18th, a freight train on the Winona & St. Peter Railroad was thrown from the track and into the ditch by a broken rail near Utica, Minn.

On the atternoon of the 18th, at Enfield, N. C., on the Wilmington & Weidon Railroad a freight car was thrown from the track by a misplaced switch.

On the morning of the 19th, at Sharon, Wis., an express train on the Chicago & Northwestern ran off the track, blocking the road soms hours.

On the afternoon of the 19th, at Fowler, Ill., on the Chicago, Burlington & Quincy's Quincy line, a Toledo, Wabash & Western express train ran over a misplaced switch and into a freight train standing on the side track, badly damaging both engines. The freight train had been run on the siding and the signal set right for the passenger train, but the switch had been left open.

On the morning of the 20th, near Jacksonville, Ill., a passenger train on the Toledo, Wabash & Western road ran over a horse, throwing three cars from the track and into the ditch on their sides.

On the morning of the 20th, at Newton, N. J., on the Sussex Railroad, as a mixed train, from which the engine had cut loose to make a flying switch, was entering the depot, the first car jumped the track, doing some damage.

On the 20th, an east-bound freight train on the Central Pacific Railroad ran off the track cast of Sacramento, blocking the road three hours.

On the 20th, an extended the track cast of Sacramento, blocking the road three hours.

On the night of the 20th, on the Chicage and Northwestern, at Oshkosh. Wis., some cars of an ore train jumped the track and went into the ditch.

On the evening of the 21st, at Uilin, Ill., on the Illinois Central Railroad, a heavy timber, which had been left lying crosswise on a flat car, struck the tender of a passenger train and knocked off the fireman, badly injuring him.

On the aiternoon of the 23d, near Summit, Tex., on the Galveston, Houston & Henderson road, some cars of a mixed train were thrown from the track by the spreading of the rails. A brakeman was injured.

On the night of the 23d, on the Petersburg Railroad, the three rear cars of a freight jumped the track at Mud Island Gut, N. C., and one was badly wrecked.

On the morning of the 24th, on the Texas & Pacific road, a trestle bridge over Little Cypress River, near Jefferson, Tex.,

which had been undermined by a freshet gave way under a passenger train, throwing the engine, tender and baggage car into the stream, the reat of the train remaining on the track. The engineman was injured and the fireman killed.

On the morning of the 25th, on the Galveston, Harrisburg & San Antonio road, near Weimar, Tex., three cars of a mixed train ran off the track and into the ditch.

On the afternoon of the 25th, on the New York & Oswego Midland road near Westfield, N. Y., the mail train bound west was thrown from the track and the baggage car wrecked.

Shortly afterwards a wrecking train going to the assistance of the mail jumped the track also near Westfield, wrecking the ragine and tender.

On the night of the 25th two cars of an express freight train on the New York & Oswego Midland road jumped the track two miles esst of Westfield, N. Y.

Very early on the morning of the 28th, afreight train on the Indianapolis & St. Louis road was thrown from the track at Mattoon, Ill., by a unisplaced switch.

On the night of the 27th, on the Eric Railway near Hohokus, N. J., there was a collision between a coal and a freight train by which several cars were wrecked.

Early on the morning of the 28th an express train on the Grand Trunk Railway ran into a specal engine which was running ahead of it, near Gananoque, Ont., injuring the engineer, fireman and a brakeman of the express.

On the 28th, on the Virginia & Trackee Railroad at the Fort Homestead Tunnel, New, several cars of a freight train impedituation of the 28th, on the Northern Central Railway, the boiler of the engine of a freight train exploded while the train was standing on a siding near York, Pa. The firebox was thrown into a field 18 feet above the track and 400 feet from the opinie, was killed and the engineer and conductor of the other brakeman were badly injured.

On the afternoon of the 28th, in Jersey City, N. J., on the Harsimus Branch of the Pennsylvania Railroad, near the junction with the main line, there was a butting collision between two

This is a total of 88 train accidents, by which 13 persons vere killed and 49 injured.

These accidents may be classified according to their nature and causes as follows:

Crossing collisions

Crossing collisions

Crossing collisions

Crossing collisions DERAILMENTS:
Unexplained
Snow on track
Misplaced switch.
Cattle on track
Broken ra l.
Spreading of rails.
Liroken wheel or flange
Broken track
Liroken wheel or flange
Broken track
Liroken sakle.
Broken oonnee ing rod.
Tie falling on track.
Dropped brake-beam
Malicious obstruction.
Tree blown on tr ck.
Caving in of ground
Broken bridge
Bridge or cuiveit washed out DEBAILMENTS:

Explosion of boiler...
Explosion of steam-chest
Cyfunder had blown out.
Flue-plug blown out.
Plug blown out.
Lanu-sitiat
Projecting timber on car.
Bunaway engine.

One collision was caused by bad side-tracking, one by a mis-placed switch and two were with ears blown from a side track to the main line. Twenty-two accidents were caused by dcfects or breakages of road or rolling stock and three of the u:.explained derailments (probably many more) can be attributed

bad condition of track.

Twelve accidents caused the death of one or more persons; 14 others caused injuries, leaving 62 accidents which caused

As in February, the number of accidents is much less than for the same month last year, when 112 accidents were recorded, by which 18 persons were killed and 92 injured. Accidents resulting from snow on the track still continue to be recorded, most of them on the Central Pacific, where more trouble was experienced from snow during March than for all the preced-ing Winter months. The number of accidents for the month as well as that of killed and injured is considerably below the monthly average recorded for the year.

For the twelve months ending with March the record stands as follows:

Month.	No. of	Accidents.	KilleJ.	Injured.
April		11	23	88
May		79	10	113
June			12	1:4
July			18	80
August			63	155
September			29	75
October			11	47
November			11	50
December		80	- 16	43
January			18	98
February			. 25	49
March			13	49
		-		-
Totals		1,146	249	951

The average per day for March is 2.84 accidents, 0.42 killed and 1.58 injured; for the year it is 3.14 accidents, 0.68 killed and 2.01 injured.



Published Every Saturday.

conducted by

8. WRIGHT DUNNING AND M. N. FORNEY.

CONTENTS.

ILLUSTRATIONS: Page	Page
American, Mogul and Ten- Wheeled Locomotives	The Cleveland, Columbus, Cincinnat & Indianapolis
facing 143	
	GENERAL RAILBOAD NEWS:
tive 147, 148	Elections and Appointments 144
CONTRIBUTIONS:	Traffic and Earnings 145
The Proposed De'aware River	Personal
& Bound Brook Railroad-	Chicago Railroad News 145
An old Scheme Revised 144	Old and New Boads 145
Pass is for Master Mechanics 144	MISCELLANEOUS:
Perpendicularity of Leveling	Co uparison of the Merits of
Rods 144	the Mole of Building Iron
EDITORIALS:	Truss Bridges in America
The I linois Railroads 142	with the System used in
America and European Lo-	Europe 139
comotives 143	Transportation in Congress 14:
The E ie and its Auditor: 143	Train Accidents in March . 140
Becord of New Ha Iroad Con-	Catechism of the Locomo-
struction 144	tive 147

Editorial Announcements.

Addresses.—Business letters should be addressed and drafts made payable to The RALLROAD GAZETTE. Communications for the attention of the Editors should be addressed EDITOR BALLROAD GAZETTE.

Contributions.—Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies, the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and in their management, particulars as to the business of railroads, and suggestions as to its improvement. Discussions of subjects pertaining to all departments of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.

THE ILLINOIS RAILROADS.

Complaints have been made against what the Illinois Railroad Commissioners' Report does contain; but we feel more inclined to find fault because of what it does not contain. The one incontestable service which such a bureau can render is the collection of information. Now the Illinois Commission sends out requisitions for reports, like any other, but the returns tabulated are extremely meagre and unsatisfactory. The Commission having been created largely because of complaints of extortionate tariffs, there is no statement and no information from which a statement can be deduced of the average charges in the State or of any single railroad in it: one of the chief questions before the Legislature being the limitation of the supposed extravagant profits of railroad proprietors, and the recommendations of the Commissioners themselves being based on such a supposition, the report nowhere shows what profits have been received by the owners of the railroads of the State as a whole, or of any one of those roads. Not even is the bulk of traffic in the State reported-information so important from many points of view; and generally any attempt to make deductions from the returns is met and partly defeated by their inadequacy and imperfection. For the lack of completeness under the several heads, doubtless the railroad companies are more to blame than the Commission; but there are too many heads wanting; and if the Commission has sufficient authority granted it, due diligence ought to compel the delinquent companies to fill up the blanks and take pains to make their

Another and a very serious fault of the report is its failure to make any deductions from the returns. They seem to have been considered as curiosities, of no practical use to the Commission, the Legislature or the people, in their proposed action on railroad business. Indeed, it is only by much hard work and the expenditure of considerable time in making calculations that the information in the returns can be made available-work which the Commission seems not to have cared to do, and which, we venture to say, not one man has taken the trouble to do of the hundreds in Illinois who have been ready to plan and put into execution laws revolutionizing the business of railroad transportation. It is almost useless to present vast tables and volumes of statistics to the average public or the average legislator. Not only are most men incapable of deducing from them the lessons which they should teach, but very few even of the most capable and interested men have the time to spare for making such deductions. They should, therefore, always accompany the tables themselves so that he who runs may read.

In the analysis which we have made of the tables of the Illinois report, our work has been limited by the deficiencies and imperfections mentioned above, so that we can-

not pretend to give anything like an adequate account of the condition and operations of the railroads of the State for the year reported, which ended June 30, 1873.

The reports are from thirty-eight railroad companies, with an aggregate of 4,516.54 miles of main line and 1,600.18 miles of branches within the State of Illinois, a total of 6,116.72 miles. Nine companies with an aggregate of 773.43 miles of road fail to report cost of road and equipment, but the aggregate cost for the other twenty-nine roads, with 5,343.29 miles of line, is \$240,893,665, an average of \$45,083 per mile. All the roads but one (Grand Tower & Carbondale, with 24.15 miles of road) report stock and debts, which for the 6,092.57 miles reporting are as follows:

Per mil .
\$21,503
20,504
\$45,007
686
\$45,693

The equipment of this 6,117 miles of road consisted of 2,117 locomotives, 1,191 passenger and 61,135 "other cars, or an average of 0.211 locomotives, 0.195 passenger cars, and 9.994 other cars per mile of road.

The train mileage is not reported, or not fully reported, for five of the less important roads. For those reporting, it is as follows:

2	Mileage of road reporting.	Train mileage.	Average per mile of road
Passenger	5.718	8.961.5 3	1.567
Freight		19,359,291	3,368
Other		4,35.17)	789

This is at the rate, for the whole mileage reported, of 2.14 passenger trains each way daily, 4.61 freight trains, and 1.08 service trains daily.

The following is a statement of earnings and expense for the whole mileage and the average per mile:

The earnings were:

Freight	9,898 556	52	Per mile, \$4.936 1,61% 508
Working expenses and taxes			\$7,062** 4,836
Net earnings	\$13,667.367	81	\$2,236

The working expenses here shown amount to $63\frac{1}{3}$ per cent. of the receipts, but they are too small, from the fact that three roads reporting earnings do not report expenses, and for the same reason the gross net earnings are too large. The average working expenses of the mileage reporting expenses is \$4,931 per mile, and the average earnings of that mileage (includ ng all except the Cairo & St. Louis, the Paris & Decatur and the Quincy, Alton & St. Louis—all having very light earnings) \$7,170 per mile, so that the net earnings are \$2,239 per mile and the proportion of working expenses 68.77 per cent.

Substracting the passenger receipts of the roads which do not report passenger-train mileage from the gross passenger receipts, and dividing the remainder by the gross passenger-train mileage, and doing the same for the freight earnings and train mileage, we get the following average receipts per train mile:

													1	P	888	enger.	Freight.
Massachusetts,	187	2-7	3.	 				 			. ,	 			\$1	81 1/6	#1 78
New York, 1871.	-72.			 	. 1				6			 			1	39	1 59
Pennsylvania,	1872			 				 		 					1	34	1 52
Ohio, 1872-73 .				 											1	18	1 37
Illinois																	1 51

In Massachusetts the average expense per passenger train mile was \$1.27½. We are inclined to think that an accurate division of passenger and freight expenses would show that not a tew of the Illinois roads, including some of the most flourishing, receive less than the cost for carrying passengers.

The earnings per mile vary from \$934, on the Cairo & Vincennes, to \$19,843 on the Pittsburgh, Fort Wayne & Chicago, the largest amount for a road with a large mileage in Illinois being \$17,395, on the Chicago, Rock Island & Pacific, which, with the Illinois Central, is the only road entering Chicago from the West which has not a large mileage of branches.

The proportion of working expenses to earnings varies from 51.39 per cent., on the Michigan Central, to 256.54, on the Grand Tower & Carbondale. On seven roads the working expenses exceed the earnings, these being, with the percentages, Cairo & Vincennes, 112.80; Chester & Tamaroa, 120.47; Grand Tower & Carbondale, 256.54; Hannibal & Naples, 109.11; Paris & Danville, 111.77; Quincy, Alton & St. Louis, 116.71; Springfield & Illinois Southeastern, 102.17. These seven roads have an aggregate length of 664 miles.

The report has a column for "tons of freight carried," but none for tons carried one mile. In the tonnage column the figures are wanting for no less than eleven roads. There are columns for "number of passengers carried,"

* The report says \$6,967.25, which would require 6,207 instead of 6,117 miles of road in the State to make up the total earnings re-

and "average distance traveled by each passenger," which together would enable us to measure the bulk of the passenger traffic exactly, but the figures are lacking for thirteen roads in the first column, and for eighteen in the second.

The accident table gives no causes for accidents, and no accidents except those causing injuries to persons—or rather the table is one of casualties to persons by accidents and not at all of accidents. It gives the enormous number of 207 persons killed, and 329 injured; 12 killed and 52 injured being passengers; 76 killed and 178 injured, employees, and 119 killed and 99 injured, "others"—doubtless nearly all trespassers on the track.

It is much to be regretted that the report nowhere gives the amount paid in dividends and as interest on the bonded debt of the roads in the State, which, being the return made to the proprietors on the capital invested, is the chief thing needful to show exactly what the profits are which are so commonly called extortionate by the people of the State and their representatives; nor does it give tonage mileage at all, nor passenger mileage perfectly—which information is indispensable if we would determine what is the average charge per unit of service.

We have here, however, sufficient information to show very nearly what have been the average earnings of the capital invested in Illinois railroads. As set forth above, the average rate per mile of

 Stock and bonds is.
 \$44,839

 And of net earnings.
 2,239

If the stock and debts represent the value of the roads, the return on the investment, on an average, was just 5 per cent. Looking to the stockholders' profits, we must separate first the interest on the bonded debt of \$20,423 per mile, which is certainly, on the average, not less than 7 per cent. Then we have:

 Not earnings
 \$2,239

 I per cent, on bonded debt
 1,429

 Jurplus for stock dividends
 \$810

This is at the rate 3½ per cent. on the average of \$24,406 of capital stock per mile, and this is what the Illinois railroads earned for their stockholders during the year reported.

As the charge is made that the stock and debts of some of the roads vastly exceed their real cost and value, we may lo well to see on what cost the above net earnings would form any given interest. Taking the excess above interest on bonds, which latter must be paid to keep the road out of bankruptcy, and amounts to \$310 per mile, it would be:

		cent	01	n.					•		 . ,				 					 						 	1	8	8	3,1	10	0
9	64	6 +		:									į.				 			 	ï					 			5	0.6	00	iO
8	81	6.6				 				 					 	 										 		1	10),]	12	ō
7	815	44																												1,4		
6	61	66																												3,1		
5	44	6.6																												3,5		
1000								,													,											

The figures in the last column being substituted for the 324,405 of capital stock.

Taking the entire net earnings, including that part paid in intrest on bonds, they are equivalent to interest at the ollowing rates on the following amounts per mile:

0	per	cent.	on		. ,							 						. ,					 			\$25
9	6.6	6.						 														 				. 24
8	66																									. 2
7	6.6	64							 	 			 										 			. 3
6	66	44																								. 8
5	66	0:																						С		. 4

The latter, amount being only \$50 less than the actual mount of stock and bonds per mile.

It is, then, plain enough that the railroads of Illinois are not, on the whole, making extortionate profits. No one will say—no one who knows anything of the cost and value of railroad property at least—that the average cost of Illinois railroads, which include a very large amount of very costly city property for termini, can be less than \$35,000 per mile, which is \$14,577 per mile more than the bonded debt. Now the excess of net earnings over the bonded debt is \$810, or about 5½ per cent. on the above mount. As a matter of fact, 30 of the 38 companies reporting paid no dividends, and 10 have since the close of the year covered by the report failed to pay the interest on their bonds. These defaulting roads have an aggregate length of 1,353 miles, which is 22 per cent. of the mileage of the State.

Briefly we may summarize the average condition of the Illinois railroads for the year ending June 30, 1873, as follows:

	Cost	\$45,083
Ì	Bonded debt	20 504
١	Stock	24.503
١	Stock and bonds	45,007
Į	Floating debt	686
J	Freight earnings	4.936
ı	Pagent on comings	1.618
1	Passenger earnings	
ı	Other earnings	508
Į	Total gross earnings	7,062
1	Gross earnings of roads reporting expenses	7,170
ł	Working expenses and taxes	4,931
ı	Net earnings	2,239
	Percentage of expenses	68.77 per cent.
	Per cent, of net earnings on capital	5.00 per cent.
	Interest charges at 7 per cent	\$1,429
1	Surplus available for stockholders	810
	Percentage on stock of surplus, or limit of possible	***
	ave.age dividend	314 per cent.
1	Average earnings per passenger-train mile	\$1.07
	" " freight-train mile	1.51
	Passenger-train mileage per mile	1.569
	Freight-train mileage	
		3,368
	Other train mileage " "	789

In conclusion, we will endeavor to find how great a margin for reducing rates these returns show. Assuming that it is not intended that they be made bankrupt by a

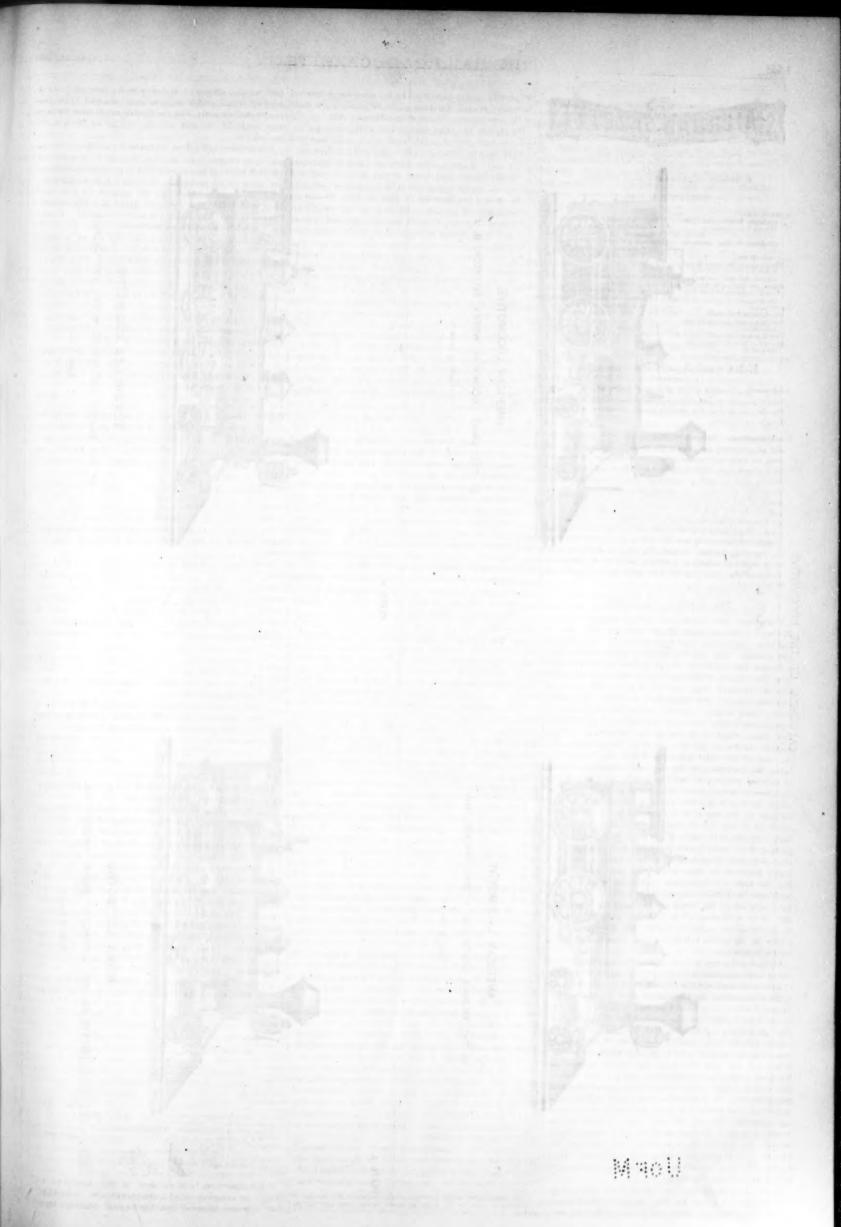
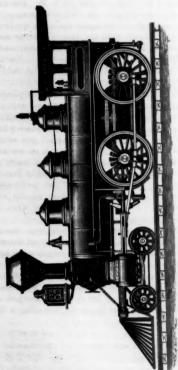


PLATE 1.

PLATE 1.

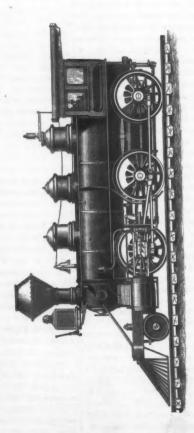


AMERICAN LOCOMOTIVE,

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Scale, 1/2 in.-r ft.

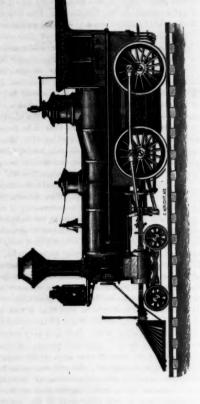
PLATE 3.



MOGUL LOCOMOTIVE,

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Scale, 1/4 in.-1 ft.



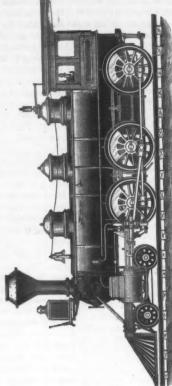
AMERICAN LOCOMOTIVE,

BY THE GRANT LOCOMOTIVE WORKS, PATERSON, N. J.

Scale, 1/2 in.-r ft.



PLATE 4



TEN-WHEELED LOCOMOTIVE,

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Scale, 1/2 in.- r ft.

fai on tal no tre av ste ev tre Ju

what was two lay proof on the proof of the country of the country

failure to make net earnings enough to pay the interest on the bonded debts, we have available \$810 per mile, by taking which from the stockholders and leaving the latter no income at all, we may reduce the average charge for transportation. Now \$310 is nearly 11½ per cent. of the average gross earnings per mile; so by depriving the stockholders of the Illinois railroads of all income whatsoever, whether divided or undivided, the average rates for transportation in that State during the year ending with June last might have been 11½ per cent., or about one-ninth, lower than they actually were.

AMERICAN AND EUROPEAN LOCOMOTIVES.

It is somewhat singular that a difference as great as that which exists in the construction of locumotives in Europe and this country should be maintained. Here for the past twenty years the designs of locomotives have been steadi forming more and more closely to each other, and probably four-fifths of those now in use are constructed on what has for that reason been called the "American Locomotives of that plan, as constructed by different builders, are now so nearly alike that it is often hard to distinguish those made at one shop from those made at another. In Europe the condition of things is quite dif-From the admirable engravings published by our able and enterprising cotemporary, Engineering, of the locomotives exhibited at Vienna, a very good idea of Conti-nental practice can be formed. While in this country our practice has to a certain extent settled down to fixed and definite forms, in Europe the widest latitude seems to prevail in the construction not only of details, but in the general plan of locomotives. Here all engines, excepting those used for switching or "shunting," are made with a flexior, as the French call it, an "articulated" wheel-base; that is, a truck or "bogie" of some kind is used. In Europe the wheels of probably a large majority of the en es are attached rigidly to the frames. Many freight locomotives there have six or eight wheels, all coupled, and many passenger engines four wheels coupled and one pair of leading wheels, all of which are held rigidly in the There is, it is true, some show of reason for this, as we have heretofore pointed out, in the fact that the tracks of European railroads are usually so much better than ours; but this reason is beginning to disappear as our main lines improve—as many of them have—in this respect. It is, however, undoubtedly a fact that for our gh and crooked roads the "three-legged principle," as it has been called, is very important. This principle is illustrated and was named from the fact that a three-legged stool will stand steadily on any surface, however uneven; whereas with four legs, if they are of the same length, the surface must be a plane in order that they may all bear equally. Our "American" engines in reality rest on three points, those on the centre of the truck in front, and the equalizing beams between the driving wheels. would, of course, not be impossible to accomplish the thing with engines having six or eight wheels coupled. Usually, however, this is not done, and even if it were, we would be without the lateral flexibility which the truck gives. We are inclined to believe, however, that the importance of both of these principles has always en overestimated, that the causes which made their adoption necessary have to a great extent disappeared, and that we are now doing what is not unusual-believing in reasons which originally rested on true premises, which have since changed so as to make the conclusions un-At the present time, our practice in the construc tion of heavy freight engines is a sort of compromise between the American truck system and that still adhered to in Europe. The way in which this developed is som what singular. Forty years ago the two initial types of engine in use were the "Grasshopper" engine, in use on the Baltimore & Ohio Railroad, and the truck engine on the Mohawk & Hudson Railroad. As the business of these roads increased, larger engines were required. On the Baltimore & Ohio eight-wheeled coupled engines were built, and on the Northern roads the present American type, with four wheels coupled and a leading truck, wa igned. These two systems were developed in the two ns, and to a very great extent seemed to be localized in different lines of latitude. With the development of the milroad system the eight-wheeled coupled engines were eent northward and the truck engines southward; so that the two systems met and worked side by side so that their respective advantages soon became apparent. gave a much greater adhesive power, and the latter the ost flexibility. As these were both important, the next step was to combine the two. To do this engines like shown in plate 4, on another page, with six wheels coupled and a leading truck, were designed, the object ng to give them more adhesive weight than was possible with what has since been called the "American" plan, own in plates 1 and 2, and at the same time have a flexible wheel-base and to some extent retain the three egged principle. Many such ten-wheeled engines, as know, were built at one time, readers and we believe it is still the standard form of engine on the Pennsylvania road. They have, however, of late years

not met with much favor outside of Pennsylvania, and on nearly all Western and Northern roads the American plan is preferred. The Bissell truck, however, rendered it sible to make a still closer approximation to the rigid wheel system and at the same time retain, in theory at least, the flexible wheel base. On a ten-wheeled engine it was impossible to bring the front driving-wheels close to the cylinders, on account of the back truck-wheels, which are behind the cylinders. With the Bissell truck, having a single pair of wheels in front of the cylinders, the front driving-wheels can be brought up close to the cylinders (as shown in the Mogul engine, plate 4,) and thus secure more adhesive weight than with the ten-wheeled plan. The next step was to add another pair of driving-wheels to the Mogul plan, thus giving eight wheels coupled with a Bissell truck in front. It will thus be seen that although the flexible wheel-base was nominally retained, yet the length of the rigid wheel-base, in the latter or Consolidation pattern, as it is called, is quite as long or even longer than in the old engines with eight wheels all connected. Doubtless the wheels of the Bissell truck serve a good purose in carrying the overhanging weight of the cylinders and are also a safeguard against the breaking of the front axle or wheel flange. The latter is, however, much less liable to happen now, when steel tires are exclusively used, than it was when cast-iron wheels and tires employed, as they were on the old camel engines. It will thus be seen that our practice in the construction of neavy freight engines is almost unconsciously approxima that which is in use in Europe, and it is that the next step may be that some one will conclude that the consolidation plan of engine may be operated without the leading truck wheels. It is of course impossible now to say what may be accomplished by the double-truck system for engines, which Mr. Mason is working out with so much skill, and which, for very powerful engines, certainly has some great advantages. It is obvious, howcertainly has some great advantages. ever, that our practice in the general plan of construction of heavy freight engines is approximating that so much ed in Europe. In the lighter class of engines, or perhaps we should say in the faster class of engines, the difficulties in the general plan are still maintained. There are, perhaps, some indications that in this direction European engineers are adopting some of our methods of construction, as the truck is now much oftener used than it was formerly. It is probable that a much larger proportion of our engines must be used for fast service in this country than in Europe. Many of our lines which do a heavy business are obliged to do it on a single track, so that trains are crowded and must run fast in order to get out of each others' way. With double-track roads, and a better classification of trains, of course this is not necessary, and onger trains and slower speeds are then possible.

It is not, however, in the general plan of construction lone that our practice differs so much from the European. In all the details there is in Europe a much greater variety of construction than here. American engines have, as it were, gradually crystallized into certain definite and fixed Outside cylinders and inside frames are now universally used here, whereas on the Continent cylinders and es are sometimes placed inside of the wheels and some times outside. The steam chests here are always placed on the outside and top of the cylinders; thus they are often laced on the side and inside the frames. Almost the only kind of pistons which seems to be used there is that made with solid heads, with simple grooves turned on the outside, into which steel, cast-iron or brass rings are sprung. Here the varieties of packing in use are numberle simplicity and cheapness, the European is certainly very much superior to ours. Here the only valve-gear now made is the shifting link-motion worked from eccentric on the main axle; there the shifting link, the suspended link, the Allen or straight link, the Walschaert* and several other kinds of valve-gear are used. Some of them are worked from eccentrics placed outside of the wheels, and in at least one engine we notice that the axle-bearings are outside of the wheels and then the eccentrics are placed next the bearings and a crank outside of them to which the connecting-rods are attached. Here all wheel-centres are made of cast iron; there, of wrought iron. In the tires for our truck wheels we are imitating Europeans, and steel tires are now much used here for that purpose. springs in American engines are, if we except the Boston & Albany Railroad, always placed above the axles and frames. In Europe they are often below. Here they are, excepting in four-wheeled engines, always arranged with lizing levers; there this is not always the car e of plate frames is universal in Europe, whereas in this country they are now never used.

In the construction of locomotive boilers there is also a very great difference in their practice. The steam dome is there always placed either about the middle or near the front end or smoke-box. The "Becker" pattern of boiler is also much used, especially in Germany and Austria. In this plan the outside of the fire-box instead of being arched is rectangular—that is, the top of what we call the wagontop instead of being round is flat, and is raised somewhat

above the barrel of the boiler. The corners are, ho rounded somewhat. The crown-sheet, instead of being stayed with crown-bars and braces, is supported by long ay-bolts ser-wed through the outside she sheet. Some of the engines which are to be built at the Grant Locomotive Works for a Russian road are to be made in this way. This is, we think, a very excellent plan, and is quite certain to be adopted in this country when its merits once become known. Shaking grates are, however, seldom shown in the illustrations of European en but grates very steeply inclined are still much used there It is very singular that in Europe the exhaust steam almost universally is allowed to escape at the base of the smoke-stack instead of the bottom of the smoke-box as is the practice here. It will also be observed that there many of the smoke-stacks are made conical; that is, the base of the inside of the stack is smaller than the upper part. have seen it stated somewhere that it is found that the steam blast is much more effective with this form than with a straight stack. We do not know, however, upon what the assertion was based, and would be glad to get ome further information in reference thereto.

The differences in points of detail are almost numberless and are well worth study. The reasons for many of se differences would be very interesting if carefully examined, and we intend to return to the subject again. very striking fact, however, is the much greater variety in methods of construction adopted in Europe than is in use here. The reason for this we believe to be, singular as it may seem, partly political. The suppression or rather sion of individuality under republican governments has often been remarked. In this country perhaps no principle is more generally believed than that "the majority should rule." The result is that this axiom produces a kind of intellectual subserviency of the individual to the will of the majority, which thus to a very great extent becomes the standard of right and wrong. If therefore any new method of construction fails to be approved by a majority, it is abandoned. We will not unde determine whether the suppression of individuality is a gain or a loss. It is quite certain that originality is very expensive when it exercises itself in the construction of locomotives or other railroad machinery, and that the Chinese virtue of uniformity has much merit and is often profitable when great ingenuity and skill would not be.

The Erie and Its Auditor.

Mr. S. H. Dunan, who resigned his office of Auditor of the Erie Railway on the 11th ult., and at that time made charges that the accounts of the company had been falsified in such a way as to show a favorable result of the management, has published a circumstantial account of the acts which he complains of. Briefly, it is to the effect that the President knew the accounts of the operations up to July, 1873, proved that the expenses were largely in excess of the receipts; that then Mr. Dunan consented to such a modification (in itself a falsification) of the accounts as would show earnings equal to the working expenses. At that time and until the 25th of August the Auditor says that Mr. Watson declared that no dividend should be de clared. But after a board meeting on the 27th of August, at which Mr. S. L. M. Barlow, who held proxies for a majority of the stock, insisted that a dividend shon clared, the Third and Fourth Vice-Presidents were sent for, and after their visit letters from them were produced which formed the basis of entries which took \$1,123,000 from the expenses, and gave the amount necessary for dividends of 31 per cent. on preferred and 1 per cent. on common The basis of the change, as we understand, was that the road, on coming into the hands of the present management, was in extraordinarily bad condition, and "reparation account" was instituted to which was charged the expenses for those repairs which put the property into better condition than when it was received

The result of this, Mr. Dunan says, was that more than \$3,300,000 of the proceeds of the \$8,000,000 convertible bonds were used in one year to pay working expenses and dividends.

The statement of expenditures on capital account from the proceeds of the \$8,000,000 loan published in London in February, when the new loan was put on the market, varied from the true statement, according to the ex-Auditor, as appears below:

or a secondar to open and a second	Company's statement.	statement.	
Cost of road and equipment Improvement of branch roads Purchase of coal lands	747,195 82	\$2,822,405 00 112,266 26 717,599 50	
Total	\$7,29 ',674 46	\$3,652,270 76	

Mr. Dunan closes his letter to Mr Watson by saying: "I have shown, in my report to the Board of March 3, 1874, that there was a deficiency in the capital account for the fiscal year 1873 of \$3,677,911.16. The facts and figures therein given are incontrovertible. The books and accounts prove them conclusively. No mere assertion can alter or change them. The entries which have been made to change the true accounts into the false throw the books

^{*} Mr. Mason is now building an engine with this valve-gear.

A

Ita din Stu Pe Ch are bu let E.

po Ra Ra

wo as La sot

Middir Bro Geo W. Beo

Rai wer lett son S. I of Geo A. i

thre

begi

out of balance and stand on their pages as a blot upon your name and mine.

Now all this has a bad look. It will not do to say or to prove that Mr. Dunan is not what he ought to be, or that he has used this statement for the purpose of affecting the stock market. He may have done all this with the est motives; not his motives but the truthfulness of his statement is the main question. His charges are definite and cannot be met by a general denial.

No statement has yet been made by the company, President Watson having but just arrived from Europe; but very likely one will be made directly, and it will be awaited with great interest.

Whether the statement be true or false, it seems to us that the case is one which brings into prominence a grave defect in American railroad organization generally. Mr. Dunan, the Auditor of the Eric Company, like most or all similar officials of American railroad companies, was the appointee and direct servant of the administration of that company, holding his office at the pleasure of the President, or of the President and the Executive Committee of the Board. Of course, under such circumstances it is impossible for the accounting officer to be a check on the administration; and with this prevailing arrange ment a railroad manager not only may do pretty much what he pleases with the road intrusted to him by its proprietors, but he practically audits his own accounts.

In England, the auditors (for there are more than one usually) are not only independent of the President, but of the Board itself, being chosen by a separate vote at the meeting at which the shareholders choose directors, and having independent authority. It is also the practice, we believe, to permit the minority, when there are parties areholders, to name one of the auditors. It is true that the English auditor's duty is rather to verify accounts than to keep them, and that in many ways his position is not comparable to that of the American offi But the feature to which we desire to call attention is his independence of the administration. He forms a real where our companies have none. It seems to us that a reform in this direction is desirable, and that our companies might well consider the propriety of making their auditing officers independent of the management whose accounts they audit, and of securing to any considerable minority of stockholders the right of naming one auditing officer with full authority to examine all accounts.

The Cleveland, Columbus, Cincinnati & Indianapolis Railway.

The report for 1878, a summary of which we published last week, is the more interesting at this time because of the change of the management made in the middle of the year, and parties among the stockholders, one in favor of and the and parties among the stockholders, one in layer of and the other opposed to the present management. Originally the division was entirely on a question of policy, which concerned a lease to or consolidation with, or at least practical working as part of, the Atlantic & Great Western. The old manage-ment had a reputation for ability and success, as the present one certainly has. But we understand that there have been insinuations at least that the line has not been economically worked since the change. It certainly is hard to find any in-dications of any considerable change in either direction in the report for the year, which covers an equal time under each management. With an average mileage greater by 10 per cents, and an increased train mileage of 11 per cents, at an increased expenditure for working of 7.22 per cents, the gross earnings were increased 6.85 per cents and the not earnings 6.15 per cents, and the surplus after paying interest charges 5½ per cent. The average cost per train mile was 82½ cents in 1872 ement. With an average mileage greater by 10 per cent., cont. The average cost per train mile was 82½ cents in 1872 and 78% cents in 1873, there being thus a considerable decrease (about 41/2 per cent.) in this unit of expense, which is probably the fan

cobably the fairest one to take.

An extremely interesting table of the tonnage mileage, receipts, and receipt per ton per mile, for through and way for eastward and westward freight is given in this report. this it appears that 74 per cent. of the tonnage mileage and 64 per cent. of the receipts were from through freight, carried at an average price of 1.175 cents per ton per mile, while the average receipt from way freight was 1.899 cents per mile. Of this through freight 82 per cent. earning nearly 80 per cent. of the through freight earnings and 51 per cent. of the total freight earnings, at an average rate of 1.139 cents per mile, was east-bound; the through west-bound freight, at an averwas east-bound; the through west-bound freight, at an average rate of 1.34 cents per mile, earning only 20 per cent. of the through freight earnings and only 13½ per cent. of the total freight earnings. Of the way freight, 72 per cent. was east-bound, with earning 67½ per cent. of the way freight earnings and 24½ per cent. of the total freight earnings, at an average rate of 1.818 cents per ton per mile, the average rate for west-bound way freight being 2.093 cents. Of the total freight earnings milescen pearly 80 per cent was cest bound coming tonnage mileage, nearly 80 per cent. was east-bound, earning 75 per cent. of the total freight earnings, at an average rate of 1.295 cents per mile, the average rate on all west-bound freight being 1.611 cents per ton per mile, and on all freight 1.362 cents. This road's average rates appear to be a trifle lower than those of the Lake Shore even, and only higher than the unprofitable Philadelphia & Erie among all the lines of which we have reports. Situated as it is, running at an angle of near y 45 degrees with the prevailing current of traffic, and crossed at short intervals by competing lines, many of which have shorter routes, it is compelled to accept lower than average rates, and is as successful only by reason of its low capital account, good management, and the prosperous and populous country on its route. being 1.611 cents per ton per mile, and on all freight 1.362

Record of New Rallroad Construction.

This number of the RAILROAD GAZETTE has information of

he laying of track on new railroads as follows;

Baltimore, Pittsburgh & Chicago.—Extended from Deshler setward 22 miles to a point within six miles of Defiance, O. This makes a total of 303 miles of new railroad completed in the United States in 1874.

Contributions.

The Proposed Delaware River & Bound Brook Rail-road-An Old Scheme Revised.

PHILADELPHIA, April 8, 1874.

TO THE EDITOR OF THE RAILBOAD GAZETTE:

The "Delaware River & Bound Brook" item in the Gazette of 4th instant, to the effect that a company has been organized, under the free railroad law of New Jersey, to build a railroad from the New Jersey Central Railroad at or near Bound Brook, on the Raritan River, to the Delaware River at or near the nouth of Moore's Creek, below Lambertville, a distance of about twenty-seven miles," is indicative of the resuscitation of an old project, or of a new project on old ground.

At irregular intervals, through long years of the past, efforts were made to compass the construction of a railroad between Philadelphia and New York, to divide the through traffic with the long reigning and legislatively absolute "Camden & Amboy" organization (now locked in the grasp of the Pennsylvania Central under lease), and meantime open for local traffic a new route northwest of Trenton, between the two great cities which command the commerce and manufactures of the nation.

When the North Pennsylvania Railroad was incorporated in 1852, it was the design of its originator that it should comprise s trunk line from Philadelphia northward via Bethlehem. Mauch Chunk, Pittston and Towards to the Erie Railway at Waverly, on the New York State line, with a branch via Easton to and through the Delaware Water Gap to the Eric Rail-way at Port Jervis, thus occupying the Lehigh River Valley between Easton and White Haven, the Susquehanna Rive Valley between Pittston and Waverly, the Delaware River Val-ley between Easton and Port Jervis, from an eligible point near the butt end of the line (which at the outstart was d down into the city to the docks in the centre of the port,) it seemed a logical sequence that, at some future time, somebody would consummate a connection via the North Pennsylvania with the city of New York.

If it be said that this North Pennsylvania Railroad scheme sovered much ground, it may be said that most of it is now occupied by roads in operation, the occupation of the balance

sing simply a question of time.

With the exception of that from Solomon's Gap, near Wilkesbarre, the North Pennsylvania Railroad Company's line swooped eastward down the mountain into the Wyoming Valley at Pittston, whereas the Lehigh Railroad Company's line loops westward down the mountain, grade ninety-six feet in the mile, to Wilkesbarre (where the railroad grade is 1,180 feet below the summit), the last-named company occupying and using 153 miles of the ground originally occupied by the North Pennsylvania Railroad Company survey, as published official

Pennsylvania Rauroad Company survey, as producted documents testify.

The late Charles F. Wells, of Athens, Bradford County, cooperated with the North Pennsylvania Railroad Company in 1853, and it was in large part in consequence of his representation. tations and services, more than a dozen years afterward, that Lehigh Valley Railroad interest took possession of the Susque-hanna Valley between Wilkesbarre and Waverly, and built a link of road 105 miles long, which combines strategy and profit, In a letter dated "Athens, August 14, 1868," to Mr. T. S.

Your original design of building the North Penns, Ivania Ruilroad here had the misfortune of being conceived and planned by a railroad mind full twenty years in advance of

Mr. Wells, however, lived to see his own beautiful North Branch Valley traversed by the locomotive, and to enjoy the appreciation of persons cognizant of his diplomacy which ended in success. He died in October, 1872.

yours and our people."

Returning to the Delaware River & Bound Brook item, the correspondence which follows shows that the project of a rail-road between Philadelphia and New York across the Dela-

ware River northwest of Trenton, has been in incubation long ugh for hatching out. In the fifty miles of distance between the railroad bridge at

Trenton and the lower of the two railroad bridges at Easton, there are eleven common road toll bridges across the Delaware River—an evidence of intercommunication across the river etween Pennsylvania and New Jersey. Surely it is time the Delaware River was spanned by a railroad bridge somewhere in that long stretch of town-dotted and denselypeopled territory.

TRENTON, N. J., April 22, 1853. homas S. Fernon, Esq., President Phila., Easton & Water Gap R. R. Co.:*

Gap R. R. Co..*

Dear Sm: We, the undersigned, being about to be associated with three other gentlemen residing in the State of New Jersey in a corporate capacity, according to the Legislative acts of our State passed in 1849-52, in a business which will require and result in a speedy construction of a railroad on our part, on a direct line from the Delaware River at or near Lambertville to some point on the Hudson River opposite the city of New York, and learning from the latter chause of the first section of vour charter that your board are authorized to construct "one or more branch roads with any railroad or other public improvement in the State of New Jersey," we embrace this opportunity of asking you whether, if we will

* This name, sriginally chosen for a diplomatic purpose, was banged to "The North Pennsylvania Rail oad Company" by the coard of directors on the 3d of October, 1858, under an act of the

run a road as above contemplated to the above specified point or points on the Delaware, you will meet us with a branch of your road from the city of Philadelphia, to form one continuous line of communication for the mutual benefit of both companies and the public good?

You will respond by first mail.

Respectfully yours,

CHARLES MOORE.

DEWRY WHINNEY.

OFFICE OF THE PHILA., EASTON & WATER GAP R. R. Co., PHILADELPHIA, April 23, 1853.

Dear Sirs: In answer to your joint letter bearing date Trenton, N. J., April 22, 1853, I have to say that the Philadelphia, Easton & Water Gap Railroad Company will be ready at any fitting time to supply, by a branch road from their main line, as authorized and condempiated by their charter, the Pennylvania link in a new and direct continuous railroad route between the cities of Philadelphia and New York, to cross the Delaware River at an eligible point at or near Lambertville.

Charles Moore, Egg.

CHARLES MOOBE, Esq. DEWEY WHITNEY, M. D.

The city termini being provided, the middle link will cost little for right of way, on ground available for cheap construction. Consult a map.

Passes for Master Mechanics.

CINCINNATI, O., April 13, 1874.

TO THE EDITOR OF THE RAILBOAD GAZETTE:

In the GAZETTE of March 28, in your article on the "Master Mechanics and the Convention," you express fears that, from information received, the attendance at the annual meeting will not be large, on account of the abolishing of the pass sys tem. Reference is supposed to be made here to the action of the Superintendents' Association in that matter; but the writer does not understand that any resolution has adopted by that body that was intended to prevent the giving of free passes to railroad master mechanics or master car builders who might desire to pass over any line for the purpose of attending the annual meetings of the respective associations; and he has yet to hear of the first where proper application has been made, where a pass has been refused; but, on the contrary, there is a general expres sion in favor of these associations among our leading railroad officers and prominent members of the Superintendents' Association. Your correspondent, feeling sure of this being the case and desiring to prevent any wrong impression from the article referred to, has written to a large number of railroad officers on this subject, and the replies thus far, without exception, have been in favor of the associations, and the insuring of free passes to all members desiring to attend the annual meetings.

As the information contained in these communications was intended for the benefit of the master mechanics, two of these are inclosed for publication. Both of these gen lemen are well-known railroad men, and are prominent officers of the Superintendents' Association, Mr. Fink being the Vice-Presi-Superintendents' Association, Mr. Film Soung dent and Mr. Paine the Secretary and Treasurer. J. H. SETOREL,

Secretary Master Mechanics' Association.

Louisville & Nashville and Great Southern Railroad. Office of Vice-President and General Superintendent, LOUISVILLE, Ky., April 1, 1874. J. H. SETCHEL, Esq., Sec'y, Cincinnati, O.:

DEAR SIZ.—Yours of 8th has been received. I will take great pleasure in passing the master mechanics over our road upon their making application to me.

I look upon your Association as the most useful to railroads that has yet been inaugurated, and I shall be glad at all times to do anything in my power to contribute to its success. ALBERT FINE, V. P. and G. Supt. Yours, very truly,

The Lake Shore and Michigan Southern Railway Co., \ CLEVELAND, O., April 10, 1874. \ J. H. SETCHEL, Esq., Sec'y Am. Railway M. M. Association,

Cincinnati, O.

SIR-Yours of the 8th received. We shall be very glad to have the master mechanics make use of our line in going to and from the annual convention at Chicago, and will forward passes to any who may apply, upon receipt of the applications.

We believe the previous conventions have been very useful, and that there is promise of still greater usefulness CHARLES PAINE

Very truly yours,

Perpendicularity of Leveling Rods.

ARCADE, Wyoming Co., New York, April 8, 1874. To the Editor of the Railroad Gazette: I notice several articles have of late appeared in the Gazette

on "Eliminating the Error in Leveling from Want of Perpetdicularity of the Rod."

In order to obtain a correct reading the rod should be kept still. For accurate leveling I use a block to apply to the coner of the rod, having a short string and plumb bob attache by which the rod-man keeps the rod plumb. H. B. ALLEN.

General Railroad Mens.

ELECTIONS AND APPOINTMENTS.

—At a meeting of the stockholders of the Baltimore, Pittsburgh & Chicago Railway Compeny, Indiana Division, at Auburn, Ind., April 10, the following directors were elected: A. P. Edgerton, Fort Wayne, Ind.; W. C. Quincy, Columbus, O.; John Gardner, Norwalk, O.; T. H. Garret, William Keyser, John K. Cowen, W. H. Ijams, Baltimore. The board elected W. C. Quincy, President: W. H. Ijams, Vice-President; James L. Randolph, Chief Engineer.

—At the annual meeting of the Baltimore, Pittsburgh & Chicago Railway Company, Ohio Division, in Columbus, O., April 6, the following directors were elected: W. C. Quincy, Wm. Keyser, John K. Cowan, George R. Dennis, Wm. Hogate and A. D. Smith. W. C. Quincy was elected President, Wm. Wing, Secretary and Transurer, and James L. Randolph, Chief Engineer.

-The Winons Republican, of April 8, says: "It is rumo

g-ad

he

ex-

an-

Was

the esi-

great upon

imes pt.

.,} ation, lad to ing to

tions.

seful,

INE.

1874.

AZETIE erper. be kept tached,

LLEN.

e, Pitts-at Au-cted: A. bus, O.; Keyser, elected ; James

burgh & abus, O., Quincy, Holgate ent, Wm. ph, Chief

s.

on retty good authority that Mr. Sherborn Sanborn, formerly General Agent of the Chicago & Northwestern at Milwankee, has been appointed Superintendent of the Winona & St. Peter road."

road."
—At the annual meeting of the Chicago & Alton Railroad
Company in Chicago, April 6, T. B. Blackstone, John B.
Drake and D. Willia James, the three directors whose terms
expire, were re-elected.

Drake and D. Willis James, the three directors whose terms expire, were re-elected.

—At the annual meeting of the Joliet & Chicago Railroad Company, April 6, John Crerar, T. B. Blackstone, John B. Drake, John McGregor Adams, and D Willis James were elected directors. The road is leased by the Chicago & Alton.

—At the annual meeting of the Mississippi River Bridge Company, April 6, T. B. Blackstone, H. V. P. Black, J. J. Mitchell, J. B. Drake and George Straut were elected directors. This is the company which owns the Louisiana Bridge.

—At the annual meeting of the S'. Louis, Jacksonville & Chicago Railroad Company, April 6, the following directors were chosen: John Orerar, George Straut, N. W. Green, Charles D. Hodges, L. E. Worcester, Josiah Sawyer. The road is leased to the Chicago & Alton Company.

—At the annual meeting of the State Line & Missouri River Railroad Company, at Osborn, Mo., March 25, the following directors were chosen: J. M. Walker, A. T. Hall, William B. Strong, E. R. Wadsworth, Robert Harris, Chicago, Ill.; C. E. Perkins, Burlington, Ia.; S. D. Mallory, James D. Wright, Chariton, Ia.; Joseph Truax, Alton, Ia. The six first named are officers of the Chicago, Burlington & Quincy.

—At the adjourned annual meeting of the Lewiston & Auburn Ra'r ad Gompany, J. G. Coburn, E. F. Davis, H. B. Bartlett, G. H. Pilsbury, M. T. Ludden, E. L. Wood, J. S. Randall, E. A. Little and S. M. Jordan were chosen directors.

—Mr. John Morrill, late of the Boston & Maine, has been appointed Roadmaster of the Portland & Rochester Railroad.

E. A. Little and S. M. Jordan were enosen directors.

—Mr. John Morrill, late of the Boston & Maine, has been appointed Roadmaster of the Portland & Rochester Railroad.

—Mr. Thomas Holt, Chief Engineer of the Maine Central Railroad, has been appointed Chief Engineer of the Eastern Railroad also.

Railroad also.

—Mr. C. B. Peck, late Acting Superintendent of the Leavenworth, Lawrenne & Galveston Railroad, will continue to act as General Freight and Ticket Agent, with headquarters at Lawrence, Kan. Mr. J. L. Barnes succeeds Capt. J. S. Ransom as Train Master, with office at Kansas City, Mo.

—Mr. John Loyer has been appointed Master Mechanic of the Boston, Burre & Gardner Ruilroad.

—The officers of the Pittsburgh & Western Refrigerator Company now are: President, Wilham Mullins, Pittsburgh, Pa.; B. C. Meldrum, General Western Agent, Chicago; A. F. Nafis, Eastern Agent, Jersev City. The company's business is the transportation of perishable freight between Chicago and New York.

—At the annual meeting of the City.

-At the annual meeting of the Carondelet Transfer Ferry Company in St. Louis, April 3, D. R. Garrison was chosen President, and C. R. Garrison, Secretary and Treasurer.

-Col. C. T. Pollard has been appointed Receiver of the Western Raitroad of Alabama in a suit brought by the bondholders. He is President of the company.

-At the annual meeting of the Detroit, Lansing & Lake Michigan Raitroad Company in Detroit, April 7, the following directors were chosen: James F. Joy, Detroit; John W. Brooks, John A. Burnham, H. Hunnewell, Charles Merriam, George O. Shattuck, Nathaniel Thayer, Nathaniel Thayer, Jr., W. F. Weld, Chas. L. Young, Boston; Benjamin S. Rotch, New Bedford, Mass.

-The stockholders of the Nevada County Railroad Company

W. F. Weld, Chas. L. Young, Boston; Beujamin S. Rotch, New Bedford, Mass.

—The stockholders of the Nevada County Railroad Company have organized by the election of the following board of directors: T. W. Sigourney, R. W. Tulley, N. Scarles, Nevada City, Cal.; William Watt, John Coleman, Edward Coleman, J. A. Lakeman, Grass Valley, Cal. The board subsequently elected John C. Coleman, President; F. G. Beaty, Vice-President, and George Fletcher, Secretary.

At the annual meeting of the Montreal, Chambly & Sorel Railway Company in Montreal, April 1. the following directors were elected: Felix Geoffrion, Vercheres, Quebec; S. T. Willett, Chambly, Que.; Charles Gill, Sorel, Que.; Hugh Mathewson. Montreal; N. A. Smith, John C. Baker, Stanbridge, Que.; S. R. Whitman, Frelighsburg, Que. At a subsequent meeting of the directors the following were elected officers: Felix Geoffrion, President; Samuel T. Willett, Vice-President; N. A. Smith, Secretary; James Baylis, Treasurer.

—Mr. W. D. Chipley, Superintendent of the North & South Railroad of Georgia, has resigned to accept an appointment as Eastern and Southern Passenger Agent of the Baltimore & Ohlo Railroad.

One Bailroad.

—Mr. J. H. Raymond, late Secretary of the Illinois Bailroad Commission, has been appointed Secretary of the Western Bailroad Association, whose headquarters are in Chicago. Mr. George Willard, who has been connected with this Association since its organization, and was Secretary and Treasurer until this appointment, remains Treasurer of the Association.

TRAFFIC AND EARNINGS.

The anthracite coal tonnage of the lines given for the

Del., Lack. & Western-	1873.	Inc.		P. c. of Inc. or Dec
Northward 193,155 Southward 394,907	154,103 477,580	Dec.		140. OF 100
Total	631,683	Dec.	103,621	16%
Central of New Jersey,				
Lehigh & Susquehanna Division 294,187	464,414	Dec.	170,227	33%
Delaware & Hudson . 495.849	630,449		134,600	2136
Northern Central.	182,749	Inc.	58,653	32
Shamokin Div 88,897	117,762	Dec.	28,865	2436
Totals 1.648,397	2,027,057		378,660	18%

begins December 1) for the four mouths ending March 28 was

Philadelphia & Reading. 1,332,273 Schuyikili Canal. 36,687 Lehich Yalley. 1,066,928 Pa. & N. Y. (anthracite) 191,019	1,37 ,196	Inc. or Dec. Dec. 39,922 Inc. 25,676 Inc. 27,744 Inc. 13,068	2% 233¼ 2¾
Totals	2,60),311	Inc. 26,566	1
Pa. & N Y. was 58,190	75,779	Dec. 17 589	2316

The earnings of the Midland Bailway of Canada for the two months ending February 28 were: 1874, \$28,952; 1873, \$24,037; increase, \$4,915, or 20½ per cent.

The earnings of the Intercolonial Railway for January were: 1874, \$38,352; 1873, \$50,949; increase, \$7,408, or 14½ per cent. The earnings per mile were: 1874. \$217; 1873, \$195.

The earnings of the Great Western Railway of Canada for the week ending March 20 were: 1874, £23,497; 1873, £24,275; decrease, £778, or 3½ per cent.

The sarnings of the Grand Trunk Railway for the week eading March 14 were: 1874, £39,800; 1873, £36,000; increase,

£3,800, or 10½ per cent. For the week ending March 21 the earnings were: 1874, £38,700; 1873, £36,500; increase, £2,200, or 6 per cent.

or 6 per cent.

—The earnings of the Central Pacific Railroad for March were: 1874, \$867,666; 1873, \$939,778; 1872, \$875,763; decrease, 1874 from 1873, \$72,112, or 7% per cent.; decrease, 1874 from 1873, \$72,112, or 7% per cent.; decrease, 1874 from 1872, \$8,097, or 0% per cent. For the three months ending March 31 the earnings were: 1874, \$2,510,224; 1873, \$2,521,061; 1872, \$2.039,822; decrease, 1874 from 1873, \$10,887, or 0% per cent.; increase, 1874 over 1872, \$470,402, or 23 per cent.

—The Bingham Canon Railroad carried during March 4,310 tons of freight.

—The earnings of the Milwaukee & St. Paul Railway for the first week in April were: 1874, \$151,000; 1873, \$125,700; increase, \$25,800, or 20½ per cent.

The following companies have thus far reported earnings

tor mercu.					
	1874.	1873.	Inc'se.	Dec'se,	P.c.
Atlantic & Great Western	1402,317	\$4:0 230		\$17,938	414
Burl , Cedar Bapids & M.nn.,	. 88,016	85.531	\$2,455		2%
Central Pacific	869,666	939,778		72.112	
Cleveland, Col., Cin. & Ind.,	318,976	441 386		192,410	
Chicago & Northwestern 1	.039,986	967,258	72,728		73
Erie		1,628,742	******	215.519	13%
Illino's Central	567.554	660,759		93,2 5	14%
Indianap., Bloom, & Western	151,188	112,569	38.617	-	34 1
Kansas Pacific	245,774	3 0 719		54 945	
Marietta & (incinnati	161,031	180,467		19,436	10%
Milwaukee & St. Paul	576,260	555,287	20,973	******	33
Missouri, Kansas & Texas	258,600	256,719	1 88		03
Mobile & Ohio	174.968	260,127		85,159	323
Ohio & Mississippi	297 613	330 998		33,485	105
St. Louis, Alton & Terre					
Haute, main line	104.193	122,299		18,1 6	143
St. Louis, Alton & Terre		Tabara			
Haute, branches	44.482	53.420		8,938	163
S', Louis, Kan, City & N'th'n	201,313	229,925		28,712	
Toledo, Peoria & Warnaw	98 0 32	102 491		4,469	
Toledo, Wabash & Western	404.699	471,301		66 602	

The earnings of the Catawissa Bailroad for the year ending December 31 were: 1873, \$713,012; 1872, \$677,526; increase, \$35,486, or 5½ per cent. Earnings per mile were: 1873, \$7,060; 1872, \$6,708.

—Mr. David Connell has resigned his position as General Superintendent of the Wilmington & Western Railroad and accepted a position in the Edgemoor Iron Works. The change takes place May 1.

—Major Judson B. Gayle, Superintendent of Machinery of the Raleigh & Gaston Railroad, died at his residence in Raleigh, N. C., April 7, of consumption. He was 48 years old.

—Col. William Phillips, President of the Allegheny Valley Railroad Company and a leading iron manufacturer of Pitts-burgh, died at his residence in that city on the morning of the 14th inst.

14th 1nst.
—Sir Daniel Gooch, M. P., Chairman of the Great Western Railway Company of England, was Locomotive Superintendent of that road from 1838 to 1865.

or that road from 1838 to 1850.

—The Boston Advertiser is authorized to say that the reports that Mr. Charles F. Hatch would shortly retire from his position as General Manager of the Eastern and Maine Central roads are entirely without foundation.

CHICAGO RAILROAD NEWS.

Western Live Stock Rates.

Following is the tariff per car load on live stock agreed upon by the officials of the Western, Southwestern and Southern roads, at their recent meeting in St. Louis:

FROM	To St. Louis	To Chicago	FROM	To -t Louis	To Chicag
Denison, Texas	\$100	\$130	Olathe, Kan	\$52	882
Red River, I. T	100	. 136	Coffeyvi le, Kan	65	95
Caddo, I. T	100	13)	L.dependence, Kan	65	95
Atoka, I. T	100	130	Chanute, Kan	65	93
Мивкодее, I. Т	80	110	Humboldt, Kan	65	98
Gibson, I. T	70	105	Lawrence, Kan	52	82
Vinita, IT.	65	95	Atchison, Kan	40	70
Prairie (ity, I. T	65		Leavenworth, Kan	40	7:
Chetopa, Kan	65	95		40	70
Oswego, Kau	65	95		40	76
Os uge Mission, Kan	65	95	Boonville, Mo	40	66
Parsons, Kan	65	95		30	54
Seueca, Mo	65			40	7
Baxter Spring , Kau	60			45	6
Columbus, Kan	65	95	Mexico, Mo	30	4
Girard, Kan	65		Moberly, Mo	30	4
Fort Scott, Kan			Cameron, Mo		7
Paola, Kan	58	88		1	

The rate to East St. Louis, East Louisiana, East Hannibal and Quincy is \$5 per car more than to St. Louis. The rates went into effect on the 6th inst.

Illinois Central.

The Land Department reports sales for March of 2,597.91 acres construction lands for \$18,686.18 and 160 acres free lands for \$2,240, a total of 2,757.91 acres for \$20,926.18. Cash collections for the month amounted to \$38,745.67.

The Traffic Department reports earnings as follows for March:

praion.		
In Illinois,	In Iowa,	Total.
707 miles.	402 miles.	1,10) miles.
Freight	\$70,712 00	a345,752 00
Passengers 102,884 12	42,177 85	145,061 97
Mails 6,375 0.)	8,059 24	9,434 24
Other sources 64.625 00	2,680 76	67,805 76
Total March, 1874 \$448,924 12 Actual earnings March.	\$118,629 85	\$567,553 97
Actual earnings March, 1873 532,937 95	127,821 44	660,759 39

Ohioago & Pacific.

Work has been resumed on the grading at Port Byron, Ill., and the contractors expect to have the whole line from Elgin west to Byron ready for the rails, except a short section of heavy work near Elgin, very soon. At the Rock River bridge, another pier is to be built to carry the bridge 160 feet across the flats east of the river, instead of filling in.

Chicago & Great Western.
This company, which was organized some two years ago by

the name of La Salle & Chicago to build a road from Chicago to La Salle, lately made some surveys of the line in the city of Chicago upon which it was authorized to lay its track, whereupon some of the property-ewners on the line made application for an injunction. The bill filed alleges that the company has done no work on its projected road, that the organization is only nominal, and that the company intends to lay rails in the city with some object not connected with the construction of the road.

Lake Shipments to Europe.

The Merchants Lake and River Steamship Line has twelve steamers ready to ply between Chicago and Montreal, with a new boat building. These vessels connect with steamer lines from Montreal to Liverpool, Glasgow and other European ports, so that there is but one transhipment, and that an easy one, between Chicago and Europe. Through bills of lading are given, and goods go into the bonded warehouse on arrival.

OLD AND NEW ROADS.

New York & New England.

At a meeting of the stockholders in Boston, April 7, it was voted that a committee of five be chosen and requested to confer with the trustees in powsession, and, after investigating the present condition and wants of the company, to report at an adjourned meeting of the corporation, with such recommendation as may seem to them proper with a view to securing the immediate possession and completion of its entire property. In accordance with the vote, the following persons were chosen: Hon. Charles R. Train, Dr. J. C. Ayer, Henry Saitonstall, Eben B. Phillips and George M. Rice. The chairman was suthorized to fill any vacancies which may occur. The meeting adjourned until April 21.

Parker & Karns City.

This road was formally opened for business April 8. It is 10 miles long from Parker City, Pa., southwest to Karns City, through the new Butler County oil district. It is of 3-feet

Northern Pacific.

A meeting of the first-mortgage bondholders is called, by order of the trustees, to be held at the company's office, No. 23 Fifth avenue, New York, May 21, at 11 a. m., for the purpose of act ng on the appointment of a trustee or trustees under the mortgage to fill any vacancies which may exist in the trust.

Mashington, Cincinnati & St. Louis.

Additional men are to be put on the grading, and two more su veying parsies put in the field.

Petersburg.

The men employed in the repair shops at Petersburg, Va., struck recently to obtain their back pay. It is stated that some of them had not been paid for six months past.

Boston, Clinton & Fitchburg.

A station building to cost \$100,000 is to be built in Fitchburg, Mass., this year.

Eastern.

Lastern.

At a special meeting in Boston, April 8, the stockholders voted to ratify and confirm the issue of \$1,000.000 (2200,000) sterling bonds already made, and also to authorize a further issue of \$2,000,000 (£400,000) sterling bonds, laving 20 years to run, and bearing 6 per cent, interest. Several stockholders took occasion to express dissatisfaction with the present management, but the issue of bonds was ordered by a unanimous vote of the stock present.

Central Vermont.

This company has made arrangements to run Pullman cars between Boston and Chicago over its lines and by way of Montreal and the Grand Trunk Railway. The cars are to begin running about May 1.

Shenandoah Valley.

The directors at their recent meeting in Charlestown, W. Va., resolved to arrange for the early resumption of work. The company will endeavor at least to have iron laid on that partor the road which is already graded.

Springfield, Athol & Northeastern.
Surveys have been made for a branch line 1½ miles long to Chicopee Falls, Mass. It is said that the branch will be built this season.

Easton & Amboy.

Work has been resumed on the grading all along the line and is being pushed forward, especially on the eastern end, between Bound Brook, N. J., and Perth Amboy. Work on the great tunnel through Musconeteong Mountain, near Pattenburg, is progressing as fast as the nature of the work will permit.

Grain Deliveries at New York.

In addition to the large elevator which the New York Central & Hudson Itiver Company is preparing to build in New York, it is stated that the Eric Company is preparing plans for an elevator, to be put up on some part of its property in Jersey City. The Pennsylvania Railroad Company is also considering the question of building one of large capacity, the location of which is not yet decided on, though it will most probably be on the Harsimus Cove property, where the new freight depot is being built.

Selma, Marion & Memphis.

The County Court of Shelby County, Tenn., has ordered suit to be commenced on the bond given by this company to secure the faithful expenditure of the money voted by the county in aid of the road. It is alleged that \$95,000 has been expended in direct violation of the conditions of the subscription.

Edgefield & Clarksville.

This company asks the County Court of Davidson County,
Tenn., to vote to it the \$150,000 stock of the Louisville & Nashville Company new held by the county.

Boston & Albany.

The men in the Springfield shops are working full time, but at a reduction of 10 per cent. in wages. The force employed is about nine-tenths of the usual number.

is about nine-tenths of the usual number.

Meetings.

The following companies will hold their annual meetings at the times and places given:
Central Railroad Company of New Jersey at the office in Jersey City, May 8, at 12 m. Transfer books are closed from April 17 to May 9.

Delaware & Hudson Canal Company at the office No. 71 Broadway, New York, May 12, at 12 m. Transfer books will be closed from April 30 to May 13.

Seaboard & Roanoke Railroad Company at the office in Portsmouth, Va., April 23, at 1 P. M.

Delaware Lackawanna & Western—Morris & Essex

Delaware, Lackawanna & Western-Morris & Essex Division.

On the eastern end of the new tunnel through Bergen Hill the heading has advanced about fifteen feet. Spaft No. 1 has been sunk seventy-one feet, just to the root of the tunnel.

Shaft No. 2 has been sunk about fifty feet, No. 3 about forty feet, and Nos. 5 and 6 are down to the rock, which is here about fifteen feet under the surface. At the wes. end the rock has been stripped of its covering of earth and the heading has been commenced. A commencement has also been made on the heavy cutting west of the tunnel. The trouble between the contractor and his men has been adjusted and a full force is now at work.

The Baltimore & Ohio Railroad Company has declared a semi-annual dividend of 5 per cent., on the stock of the Main Stem, payable May 1. A semi-annual dividend of 5 per cent. on the stock of the Washington Branch was also declared and became payable April 17.

Jacksonville, Northwestern & Southeastern.

Work has been begun on the extension from Virden, Ill., southeast to Raymond on the St. Louis Division of the Toledo, Wabash & Western. A correspondent informs us that the company, having been unable to sell its bonds, has contracted for some of the grading with farmers on the line, who are to be paid in transportation when the road is completed. Mr. L. S. Olimstead, of Jacksonville. Ill., is Chief Engineer.

Cincinnati Southern.

Work on the grading of divisions D and E, from Shelby City, Xy., to Chitwood is progressing steadily except on a few sections which were thrown up by the contractors, including the masonry of the Cumberland Bridge. The letting of contracts on divisions F and G has been postponed till April 8. Each division comprises about 40 miles.

Oumberland & Ohio.
Mr. E. F. Falconnet,

Cumberland & Chio.

Mr. E. F. Falconnet, the Chief Engineer, informs us that this company is about to let 40 miles of grading and masonry, between Eminence and Greensburg and between Glasgow and Scottville, Ky. There will then remain only 60 miles to be let of the whole line between Eminence, Ky., and Gallatin, Tenn., about 200 miles. The company expects to lay track between Lebanon and Greensburg, Ky., in the course of noxt Summer. Eminence is a station on the Louisville & Lexington road about 45 miles east of Louasville, and the route of the line is southeastward from that place nearly parallel with the Louisville & Nashville and generally 20 miles or more east of it.

Indianapolis, Cincinnati & Lafayette

Chicago papers state that arrangements are being made by this company and the Pittsburgh, Cincinnati & St. Louis to pool the earnings of the two roads on all business between chicago and Cincinnati. If the arrangement is completed a rise in rates is probable.

Texas, Mississippi River & Northwestern.

On this company's Chicot & Pine Bluff line some 20 miles is rendered useiess by the washing out of portions of the road by high water. The breaks cannot be repaired until the water subsides. The mail is carried over this part of the road in boats. On the Monticello line 30 miles of track is under water, much of which will have to be requilt.

North Wisconsin.

Surveying parties have been put in the field to locate the line from the terminus of the road to Ashland. It is not probable that any material change will be made in the line already surveyed.

The Detroit Bridge Question.

The Detroit Board of Trade called a public meeting of delegates from all parts of the State to consider the question of bridging the Detroit River. Resolutions in favor of a bridge were carried; but there was a strong opposition to them. The vessel-owners of Detroit have also formed an association for the protection of their interests and to oppose the erection of a bridge by all lawful means.

Leavenworth, Atchison & Northwestern.

The County Commissioners have been aske 1 to enforce the agreement under which aid was voted to this road by Leavenworth, Kan., on cond tion that that city should be the southern terminus of the road and that the machine shops, etc., of the road should be built there. The road is now leased to the uri Pacific.

Northern Central.

The adjourned annual meeting was held in Baltimore, April 9. The President reported that the Pennsylvania Railroad Company had made a definite offer to lease the road at a rental equivalent to 6 per cent, on the stock, and the interest on the funded debt. This proposition was rejected with very little discussion. It was then resolved to appoint a committee of five stockholders, not connected with the management of either company, to examine into the company's affairs and to conduct any further regotiations with the Pennsylvania Railroad Company. The members of this committee are John Hulme and H. C. Borie of Philadelphia, Lambert Gittings, M. B. Greensfelder and J. H. Williams of Baltimore.

The stockholders voted to authorize an issue of \$10,000,000 consolidated mortgage bonds, \$6,000,000 to be laid aside to exchange for outstanding bonds as they mature, and \$4,000,000 to be used to extinguish the floating debt and for new construction and equipment.

All further business, including the election of directors, was postponed to another meeting, to be held at the call of the committee of stockholders.

Of the 116,838 shares of stock, it is stated that the Pennsylvania Railroad Company owns 48,420.

Montery & Salinas Valley.

Montery & Salinas Valley.

The preliminary surveys have been completed and the engineers report that there will be very little heavy work on the line. The length of the line from Salinas City, Cal., west to Monterey will be 18 miles.

Alabama & 1 Chattanooga.

The receivers have found it necessary to reduce the train service to three trains per week each way, and the new schedule went into effect April 13.

Central, of Georgia.

Some 50 of the train hands were recently discharged at Macon, Ga., and both freight and passenger business is reported very light.

Louisiana Southern

Nachitoches, La., with other to an and parishes along the proposed line, is to be asked to vote aid to this company. The company promises to begin work under the new organization

South & North Alabama.

A preliminary injunction has been granted by the Chancery Court to restrain the collection of the special tax levied to pay the interest on the bonds issued by Montgomery, Ala., in aid of this road.

New Orleans, Mobile & Texas.

The Louisiana Supreme Court rendered a decision April 6 regarding bon a issued by the State to the New Orleans, Mobile & Texas Railroad, under the act of 1871. The Court did not pass directly on the validity of the bonds, but intimated that if the allegations made by the State were correct the bonds would be void, and remanded the case for further proof.

As the fact that the road has not been finished as required by the act is well known, there is very little doubt as to the final decision of the Court.

Old Colony.

It is stated that the Old Colony Steamboat Company, which is substantially owned by the Old Colony Railroad Company, has made arrangements to purchase the boats and other property of the Narragansett Steamship Company.

Baltimore & Ohio.

Baltimore & Onio.

It is reported that negotiations are on foot between this and the Pennsylvania Raiiroad Company for a settlement of the difficulties between them. The basis of negotiation is said to be that the Pennsylvania Raiiroad Company will agree to haul two Baltimore & Ohio Washington trains through to New York daily, provided the latter will agree to cease using the new East Alexandria Branch and will run its trains to Alexandria over the Alexandria & Washington road as heretofore.

New York Central & Hudson River.

It has been reported in New York that a movement was on foot on the part of certain English capitalists to secure a controlling interest in this company. These reports do not appear to come from any reliable source.

The contract for laying the new freight tracks around Syracuse has been let to George B. Phelps & Co., of Watertown, N. Y., who also have the contract from Oneida to Syracuse.

Union Pacific.

The Committee on Pacific Railroad of the House of Representatives has authorized one of its members to report a bill requiring this company to operate the bridge across the Missouri River at Omaha as a part of its continuous line of road. This bill is designed to put a stop to the present extra charges for freight and passengers exacted for transferring them across the river by this bridge. Ten dollars per car is now charged for bridge tolls, and passengers are compelled to change cars. The bill, in order to protect holders of the bridge bonds, provides that the Union Pacific Railroad Company shall pay the interest on them, and shall also set apart annually an amount equal to 4 per cent. of the amount of the bridge bonds as a sinking fund for their redemption at maturity.

Mr. Wardell, late Manager of the Wyoming Coal Commissions of the suit against the coal of the coal

turity.

Mr. Wardell, late Manager of the Wyoming Coal Company has brought suit against the Union Pacific Company and others in the courts at Omaha, Neb., to recover a large amount claimed to be due the coal company's stockholders. The Union Pacific Company has taken possession of all the mine and property, claiming that they own the largest share of the stock, and will hereafter run the mine in the interests of the road.

The corporators of the proposed railroad from Nevada City, Cal., to Coffax have organized the company by this name. Over \$125,000 in s 'bscriptions to the stock have been secured. The road is to be of 3-feet gauge.

Baltimore, Chesapeake & Delaware Bay.

The contractor for the grading from Queenstown, Md., to Harrington, Del., is Mr. Thomas Costigan, of Georgetown, Del. The work has been already begun, and the necessary iron, three engines and some cars have been contracted for. The work is to be pushed forward.

The work is to be pushed forward.

Baltimore, Pittsburgh & Chicago.

At the annual meeting of the stockholders of the Indiana Division it was stated that the work is being pushed forward and track-laying has been commenced. It is expected that the whole line will be finished the present season. It was voted to accept the lease of the Illinois Division.

The officers of the Ohio Division, at the annual meeting of that company, reported that the track was laid within six miles of Defiance, O., or 22 miles west of the late terminus at Deshler. The whole line through Ohio is to be finished the present year.

St. Louis & Iron Mountain.

At the special meetings of the bt. Louis & Iron Mountain, Arkansas Branch, and Cairo, Arkansas & Texas companies in St. Louis, April 11, the stockholders voted to ratify the agreement of consolidation of the three companies. The consolidation takes effect at once, but is only preliminary to the further consolidation with the Cairo & Fulton Company, which the stockholders are to vote upon shortly. The name of the company still remains St. Louis & Iron Mountain.

Chicago & Southern.

A company by this name has filed articles of incorporation with the Secretary of State of Illinois. The road is to run from Chicago southward to some point on the Chicago, Danville & Vinvennes. The capital stock is to be \$250,000.

Wheeling & Lake Erie.

w noting & lisse life.

A mortgage has been executed to the Farmers' Loan and Trust Company of New York, as trustee, to secure the proposed issue of \$5,800,000 in bonds. These bonds are to be 7 per cent. gold bonds having 30 years to run from May 1, 1874, and are convertible into stock. A

North Carolina.

Morth Carolina.

The special meeting of the stockholders to vote on the acceptance of the consolidation act passed by the last Legislature was to be held in Salisbury, N. C., April 16. The act, a summary of which was given some weeks since, provides for a consolidation of the North Carolina, Western North Carolina and Atlantic & North Carolina companies, and the completion of the road west to the Tennessee line.

Western, of Alabama.

Col. C. T. Pollard (President of the company) has been appointed Receiver of this road in a suit brought by the bondholders. No change has been made in the immediate management of the road. The proceedings in court look towards a foreclosure of the mortgage and a sale of the road.

The road runs from Solma, Als., east to Montgomery and thence east by north to West Point, 138 miles, with a branch 29 miles long from Opelika east to Columbus. It is a section of the most direct route from Savannah to the West.

St. Paul & Sioux City.

St. Paul & Sioux Uity.

Since March 16, this company has been carrying seed grain and potatoes, flax seed, garden seed, fruit and forest trees, shrubs and cuttings to settlers on the line of its road between St. James, Minn., and Seney at half tariff rates, in less than car-loads. The circular from the company giving notice of this reduction announces that these special rates must cease May 4. ss under the new railroad law, which goes into operation May 5, they are unjust discriminations and are prohibited.

Minnesota Railroad Commission.

The new Board of Railroad Commissioners met in St. Paul, March 31, and organized. Their first official action will be to investigate the charges of abuses and discrimination made against the Southern Minnesota and Winona & St. Peter com-

Hoosac Tunnel Line.

The minority of the committee of the Massachusetts Legislature, who are opposed to the consolidation provided for in the majority report, have prepared and submitted a bill. It provides that the State shall take no steps toward consolidation and shall not even provide equipment for its road, but shall hold the Troy & Greenfield road and the tunnel open to

any company which desires to run trains over the line, charging a fixed mileage for all cars. Provision is made for a board of trustees to have the control and management of the line. This plan is said to have the support of the Massachusetts Central interest.

Paterson & Newark.

Paterson & Newark.

An adjourned meeting of the old stockholders was held in Paterson, April 10. The committee reported that a statement of what the Eric Company was willing to do had been promised in 10 or 15 days. Mr. Eastwood, of Belleville, was appointed on the committee in place of Enos Cole, and the stockholders adjourned to meet at the call of the Secretary. It is stated that a substantial agreement between the New Jersey and New York stockholders has been reached, and that legal proceedings will be commenced at once if the Eric Company does not offer an acceptable compromise.

Great Western, of Canada.

The company advertises for tenders for the transportation of 6,000 tons of steel rails and fastenings from Montreal or Quebec by water to Hamilton, Ont., or Toronto. The shipment will commence in June and continue until the close of navigation. Proposals will be received at the office in Hamilton until April 22.

New York, Kingston & Syracuse.

Rew Iork, kingston & Syracuse.

Ernest Caylus and others, iron merchants of New York have commenced suit against the directors for the sum of \$79,723, claiming that the directors are personally liable for Iraud, because of the violation of their duties in issuing second-mortgage bonds purporting on their face to be first-mortgage bonds, which were taken as collateral by the plaintiffs for iron furnished to the road, and such bonds being valueless.

valueless.

Oil Greek & Allegheny River.

The Philadelphis Ledger says:—"There is a report on the street that the road may be sold under foreclosure of its second mortgage, which is for \$1,100,000. The first mortgage is \$2,580,000, in all \$3,680,000. The alleged reason for this is a determination not to pay, under any circumstances, certain litigated claims of old standing against the company, on one of which judgment was recently given against the company in a lower court. This particular suit, we understand, is to be carried farther. There are, however, several other claims of large amounts of similar character, but so unjust are they esteemed by some of the parties of largest interest in the company will default in the interest on the second-mortgage bonds and permit the road to go to sale under foreclosure rather than pay them."

Memphis & Charleston.

Memphis & Charleston.

The Memphis Appeal states that the agreement by which the Southern Security Company gives up the lease includes the payment to the Memphis & Charleston stockholders of \$70,000 in money, 3,500 acres of land and, other property to the amount of \$120,000. Another report states, however, that the Memphis & Charleston stockholders will be asked to release the Southern Security Company from the payment of \$160,000 rent due. The terms of the agreement will probably not be definitely known until the stockholders' meeting, which takes place April 29.

Winona & St. Peter.

Much complaint is made concerning the failure to you train.

Much complaint is made concerning the failure to run trains west of New Ulm, Minn., since early in February. It is said that much suffering has been caused among the settlers on the line by the stoppage of trains.

Portland & Ogdensburg.

Work on the line through the White Mountains is being pushed as fast as possible. It is expected that by June 1 the track will reach the old Crawford House, and by September 1 the road will be finished through the Notch nearly to the present Crawford House. This section of six miles is the most difficult on the line and requires a very large quantity of rock cutting, much of which is already done. Work is soon to be commenced on the line from the Crawford House west to the Connecticut River and on the bridge over that river.

mun spac open whice spine

ward This

fill t so th

and d

fulero

ro i. the c be op

motiv.

toast to get

QUE

cleane

Ane cocks,

1g. 71

placed fire-bo hind, side. water

out, as mud a with th

cock by

m id at on irely mud-ho

Erie.

Mr. S. H. Dunan, the late Auditor, has published another letter, in which he reiterates his former charges and further states that alterations to a large amount were made in the operating and income accounts in order to justify the dividend declared in September. He also charged that the published statement showing the disposition made of the proceeds of \$8,000,000 convertible bonds sold is incorrect. No answer to the latter charges has yet been published, but President Watson, who has just returned from Europe, is said to be preparing a full statement of the company's affairs and an answer to Mr. Dunan's statement. It is stated that arrangements will be made to have the books examined by a committee of experts who are entirely disinterested.

The new ferry-house in Jersey City is completed and has been in uso seme little time. It has three slips, two for the Chambers street and one for the Twenty-third street ferry, and is conveniently arranged though not very large. A very serious fault in the present arrangement of the passenger depot in Jersey City, and one for which there is no apparent excuse, is the very long distance which passengers are obliged to walk between the cars and the ferry-boat. This will probably be remedied when a permanent depot is built, but meanwhile a better temporary arrangement could easily be made.

The iron has been taken up from about 3½ miles, and the ties from about a mile of the second track on the Newark Branch.

Cairo & Fulton.

The special meeting of the stockholders to vote on the pro-osed consolidation with the St. Louis & Iron Mountain Com-any will be held at Little Rock, Ark., May 4.

California Railroad Law.

The bill for regulating rates in California failed finally through a disagreement between the two houses of the Legislature, the lower house having refused, just at the close of the session, to pass the Senate substitute for the original bill. The date of adjournment was then fixed and there was no time to arrange a compromise.

Flushing & North Shore.

Efforts are being made to secure the building of the proposed extension from Great Neck, N. Y., eastward to Huntington. Brauches from the Long Island Central, which is operated by this company, are also proposed, to run southward to Hemps. ead Village and from near Westbury to Wheatley. All these proposed lines will be in direct competition with those of the Long Island Railroad Company.

St. Louis, Kansas City & Northern.

A party of the directors, officers and stockholders of this company have been passing over all the company's lines on a trip of inspection. The new shops at Moberly, Mo., received

Lebanon Valley.

A branch about eight miles long is to be built from Hummelstown, Pa., on this road southward to Middletown on the Pennsylvania road. This will serve as a short-cut line for considerable freight, mainly coal and lumber, which is now carried around through Harrisburg.

of for

any, the der-veral

trains is said on the

another I further in the dividend the pubthe project. No shed, but urope, is y's affairs ated that nined by a

and has
we for the
eet ferry,
e. A very
passenger
o apparent
are obliged
s will probbut meanbe made.
es, and the
he Newark

ailed finally of the Legis-e close of the original bill. here was no

g of the pro-to Hunting-which is ope-southward to heatley. All on with those

olders of this ly's lines on a Mo., received

ilt from Hum-etown on the t-cut line for which is now

[Entered according to Act of Congress, in the year 1874, by the RAIL-BOAD GAZETTE, in the office of the Librarian of Congress, at Wash-ington.]

THE CATECHISM OF THE LOCOMOTIVE.

BY M. N. FORNEY, Mechanical Engineer.

PART VIII-(CONTINUED).

THE BOILER ATTACHMENTS.

QUESTION 144. What is the steam-whistle, and for what pur

Answer. The steam-whistle, W, fig. 71, and shown in section in fig. 81, consists of an inverted metal cup or bell, A, made usually of brass. The lower edge of this cup is placed immediately over an annular opening, a, a, from which the steam escapes and strikes the edge of the cup or bell, which produces ep or shrill sound, according to the size or proportions of



Fig. 71.

opening, a, a, is formed by the plate or cover, a, a, which nearly fills the mouth of the oup B, which is attached to the stem c. This is screwed into the top D of the dome. Communication with the steamspace of the boiler is either opened or closed by a valve, b, which is attached to a sort of spindle, d, which extends upward inside of the stem c. This spindle does not entirely fill the opening in the stem c, so that the steam which enters when the valve b is opened rises and escapes through the holes, e, e, e, e, into the cup Band out through the annular opening a, a. The valve is opened by the lever E, whose fulcrum is at f. The end g of this lever is connected by a 101, h, figs. 81 and 71, with the cib, and by a suitable handle or lever, h, fig. 71, it can be opened and the whistle be blown at any time by the loco-motive runner or fireman to give signals to the trainmen or of the approach of a train to a station, or to warn persons to get off of the track.

QUESTION 145. How is a locomotive boiler emptied and

Answer. One or two large costs, called blow-off cocks, X, fg. 71, are provided and are placed near the bottom of the placed near the bottom of the placed near the bottom of the fire-box, either in front or behind, and sometimes on the side. By opening these the water in the boiler is blown out, and much of the loose und and dirt is carried out mud and dirt is carried out with the water. The cock, X, ig. 71, is opened by a handle, w, which is connected with the cock by a rod.

In order to clean out the mid and scale which is not and and scale which is not enicely loose, what are called mad-holes or hand-holes are placed in the corners of the fre-box near the bottom. These are oval-shaped holes, shout 1% imphes long and 21% has wide, and covered with two metal plates, one of which is put inside the boiler and the other outside, and fastened with a bolt through both. Another hand-hole is sometimes placed in the bottom of the front tube-sheet. When the boiler is emptied of water these hand-holes are uncovered and as much dirt is removed as can be scraped out of these holes. A hose pipe is then inserted and a strong stream of water is forced in, which washes out nearly all the loose dirt, so as to leave the boiler comparative-

Where the water is very impure, what is called a mud-drum, M, fig. 44, is used. Much of the mud and dirt are deposited in this receptacle, from which it can easily be removed by taking off the cast-iron cover on the bottom of the drum. The cover is also provided with a blow-off cock, only the opening for which is shown in the figure referred to.

QUESTION 146. What other attachments are there to the boiler of a locomotive?

of a locomotive?

Answer. There are two cocks, a, a, fig. 71, called heater-cocks, connected with pipes to the feed-pipes, D, D, to admit steam to the latter to prevent them from freezing. There is another cock, b, called a blower-cock, which is connected to the smoke-stake by a pipe, b. Steam is conducted through this pipe and escapes up the chimney in a jet, thus producing a draft when the engine is not working. This arrangement is called a blower and is used to blow the fire when the engine is standing still. The action of the jet is similar to that of the exhaust steam which escapes up the chimney, excepting that the steam from the jet escapes in a continuous stream instead of distinct "puffs," as it does when it is liberated alternately from one end of the cylinders and then from the other.

T is a handle which is connected by a rod, T" T, with the

T is a handle which is connected by a rod, T' T, with the feed-cock (not shown in the engraving) in the pipe D. This cock can be opened or closed by the handle, and the supply of water fed into the boiler by the pump can thus be regulated. J is a handle on the other side of the engine, for regulating the working of the pump on that side.

L, e are handles, also connected by rods with the pet-cocks

E, e are handles, also connected by rods with the pot-cocks on the pumps. These cocks can thus be opened or closed, and it can then be known whether the pumps are working.

A is the furnace door, which is fastened by a latch. The latter has a chain, Q, attached to it by which it can be conveniently opened or closed. The door also has a circular register with six holes to admit air into the furnace. These holes can be opened or closed by the revolving circular disc shown in the engraving.

QUESTION 147. How are the grates constructed?

Answer. As has already been explained, they are made usu-

ally of cast-iron bars, $^{\bullet}A$, A, A, A, figs. 82 and 83, called *grate-bars*. Fig. 82 is a plan, and fig. 83 a horizontal section of one form of grate. The bars in this kind of grate are usually cast form of grate. The bars in this kind of grate are usually east in pairs, or sometimes three or more are cast together. They are made wider on the top than on the bottom edges, as shown in the section, fig. 83, so that cinders and ashes will fall through easily, and also to give free access to the air from below. They are usually from ½ to 1½ inches wide on the top, and about ½ inch on the lower edges. The spaces between the bars are made from ½ to 1½ inches wide. For burning wood the bars are placed comparatively close together and are stationary, but for burning bituminous coal they are usually made so that they can be moved, in crder to shake or stir up the fire, just as is necessary in an ordinary stove or grate fire. In the grate we have illustrated the bars, A, A, are cast in pairs, and run crosswise of the fire-box. The ends are made with a sort of journals, b b, which rest on two supports, B B, called bearing-bars,

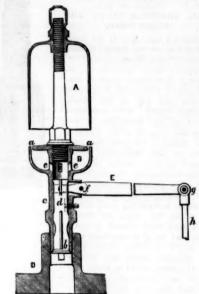


Fig. 81.

which have suitable indentawhich have suitable indentations to receive the ends of the grate-bars. The latter have arms, CC, fig. 83, cast on the under side, to which a bar, D, is attached. By moving this bar back and forth, the grate-bars have a rocking motion imparted to thom, as shown in fig. 84. It is evident that in this way the fire over that in this way the fire over the whole surface of the grates will be disturbed or shaken. The bar, D D, is moved by a lever, m m, shown in fig. 71. An extension piece, not shown in fig. 71, is used with the lever, m m, so as to increase its length: but it is removed after it has been used, so as not to be in the way of the fireman. Grates which have fireman. Grates which have movable bars are called shaking or rocking grates. A great variety of such grates are made and in use, to describe which would require more room than is available here.

For burning anthracite coal what are called water grates are used. These consist of wrought-iron tubes, 2 inches in diam-eter outside, which are fast-ened in the front and back plates of the fire-box and are inclined upward from the front end, so that there will be a continued circulation of water through them to keep them cool and thus prevent them from being burned out by the intense heat of the fire.

QUESTION 148. How is the fire removed from the fire-box when it is necessary to do so? Answer. In bituminous coal

Answer. In bituminous coal burning engines, what is called a drop-door, F F, figs. 82, 83 and 84, is provided for that purpose. This door is supported partly on journals, d d, similar to those in the gratebars, on which it can turn, and is held up or prevented from dropping by arms, ee, attached to a shaft, FF. This shaft is operated by a lever, ff, fig. 82, outside the fire-box.

*In Europe and in some few asses in this country they are made f wrought iron.

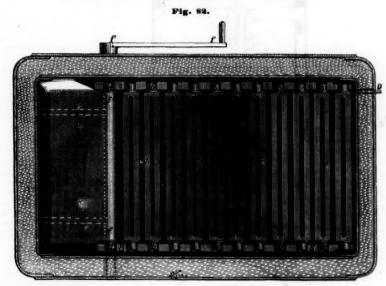
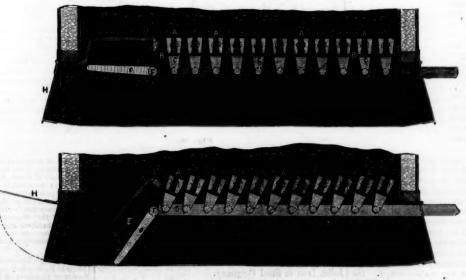


Fig. 83.



Pig. 84.